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[SECOND SERIES.]

ART. XXVIII.—*On the Sabbatic River;* by W. M. THOMSON.

JOSEPHUS in the 5th Chapter of his 7th Book on the Jewish War, gives the following description of this remarkable river.

"Now Titus Cæsar, tarried some time at Berytus, as we told you before. He then removed and exhibited magnificent shews in all the cities of Syria through which he went, and made use of the captive Jews as public instances of the destruction of that nation. He then saw a river, as he went along, of such a nature as deserves to be recorded in history. It runs in the middle, between Arca belonging to Agrippa's kingdom, and Raphanea. It hath somewhat very peculiar in it; for when it runs its current is strong, and has plenty of water, after which its springs fail for six days together, and leave its channel dry as any one may see; after which days it runs on the seventh day as it did before and as though it had undergone no change at all. It hath also been observed to keep this order perpetually and exactly—whence it is, they call it the Sabbatic River—that name being taken from the sacred seventh day of the Jews." This is the account of Josephus. Pliny* mentions this river, as is generally supposed; but he seems to imply that it ran six days and rested on the seventh. "In Judea rivus sabbatis omnibus siccatur." Pliny thus makes the river a more consistent Jew than does Josephus.

* Nat. Hist. 31, 2.

The translator of Josephus says that this famous river is now extinct: and in this opinion the learned Reland in his Palestina Illustrata concurs. And Galatinus rather sarcastically argues against the Talmudists, that—"If this river while it existed was a sign that the sabbath ought to be observed, now since it never appears, the sabbath should no longer be kept." Niebuhr, the celebrated Danish traveler, having discovered an independent tribe of Jews residing in Arabia, says—"The circumstances of this settlement have perhaps given rise to the *fable* of the Sabbatical River." What the "circumstances" were which could have given rise to such a fable, he does not mention; nor is it easy to discover, or even imagine. I believe however that the long lost river is at length found; and if this can be established, we shall not only demolish the odd argument of Galatinus against the perpetuity of the sabbath; but rescue the Jewish historian from the imputation of gravely recording idle fables.

To return to the quotation from Josephus. Titus it appears made rather a protracted stay at Beirût. He then traveled north to Zeugma on the Euphrates, dragging after him crowds of Sion's most miserable captives, whom Josephus says he everywhere exhibited as public instances of the destruction of this nation. Now it was in this march northward from Beirût, that he saw the Sabbatic River. It ran between Arca and Raphanea, in the kingdom of Agrippa. The latter part of this sentence I apprehend has extinguished the river, or at least started all travelers on a fruitless search for it. They have endeavored to find it somewhere in, or near to the kingdom of Agrippa; and as there is an Arcea and a Raphanea between Palestine and Egypt, they naturally have sought for the river there. But it is plain that we cannot hope to find it in that direction, and for two good reasons. *First*, because there is no such river there; although I read many years ago the journal of a traveler through the desert from Egypt to Jerusalem, who suggested that a wide channel or *wady* which exhibited signs of having, at times, a great volume of water—though perfectly dry when he crossed it—might possibly be the lost Sabbatical River. To any one however who has either resided or traveled in Syria, there is nothing remarkable in the dry channel of a wide stream. They are common in all parts of that country. The *second reason* is, that the narrative of Josephus absolutely requires that the river should be at a considerable dis-

tance north of Beirût. Titus was on his march towards Antioch when he noticed it. The river could not therefore have been in Agrippa's kingdom; and I think it not improbable that the words, τῆς Ἀγρίππα βασιλείας, are an interpolation of some transcriber or scholiast, intending to make the description of Josephus more definite, by limiting it to the Arca and Raphanea in the south of Palestine—the only cities of that name probably with which he was acquainted. Nor would such a geographical mistake be at all surprising. For ages, Syria was a kind of *terra incognita.* Few even of the learned knew that there was such a place as Beirût in existence; and fewer still had any accurate information as to its relative position. A transcriber therefore might very readily suppose it to be in Agrippa's kingdom, and so add the explanatory clause. The Jewish origin of the name might suggest the same thing.

This much however is certain. If Titus saw the river on his tour northward of Beirût, we must travel in the same direction to find it. Accordingly, about half a day's ride to the north of Tripoli, (or three days north of Beirût,) there was a well known ancient city called Arca or Arcea; and a few miles farther north, a town called Raphanea. *Between* these two places, no doubt, flowed the Sabbatic River. In all probability this river derived its origin and peculiar character, from one of those intermitting fountains which are to be met with occasionally in different parts of the world, and of which there are several examples in Syria. This necessary supposition will guide to the precise spot where our river first appears.

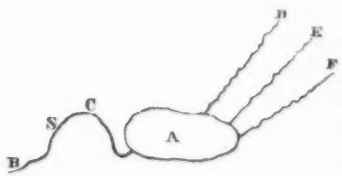
In the valley below the Kulâat Hûssn, and near the great convent of Mar Jirjius, there is a fountain which throws out at stated intervals an immense volume of water, quite sufficient to entitle it in Syria to the name of river. And it is in fact the head or source of one considerable branch of the Nhr el Kebîr, the ancient Eleutherus. This locality answers, in all respects, to the description of Josephus, with the single exception of the words, "in Agrippa's kingdom," explained above. Arca is on the south, and a village called Raphanea or Rahanea on the north.

There are however some difficulties in the account which require explanation. In the first place, this fountain at Mar Jirjius *is now*, as I was informed, quiescent *two days* and active on the *third*. The account given me on the spot was, that every third day St. George descended, and forced out the water with loud

roaring, and great violence, to irrigate the extensive plantations of this richest of Syrian convents. I examined the cave out of which the river flows, through a wide low aperture. It is situated at the base of a limestone hill or rather mountain. This limestone hill is isolated—entangled in an almost boundless region of trap rock. It was one of its resting days, when I visited the cave; but I noticed very evident traces, in the bed of the river below, of the large volume of water which had rushed along it only the day before.

According to Josephus, the river ran on the seventh day, and rested during the week; but Pliny reports that it flowed six days, and was dry on the seventh. At the present time it rests two days and runs on the third. To reconcile these discrepancies, we need not suppose either that the river (having grown old during 1800 years) requires twice as much rest as when Josephus wrote; or that St. George doubled the number of working days in order the better to irrigate his gardens. Both historians probably derived their information from general rumor, and had not visited or examined the river for themselves. And the numbers in both versions of the story were adopted, from a desire to connect so singular a phenomenon with the Jewish division of time. It is highly improbable that either of them is strictly accurate; and this has been the common opinion of the learned, without having the river itself to refer to, the actual conditions of whose activity and repose require such a supposition.

If we must admit, however, that one or the other of these statements was literally exact, (and certainly they could not have both been true,) the difference betwixt the periods of activity and intermission eighteen hundred years ago, and at the present time, admits of a satisfactory explanation. I believe it is now well ascertained that these intermitting fountains are nothing more than the draining, on the principle of the syphon, of a subterranean pool or reservoir of water.




Let A represent such a reservoir, under the mountain upon which stands the convent of St. George; S the syphon, which of course must commence at the bottom of the pool, rise over an elevation, as at C, as high as the water rises in the pool, and terminate lower than the pool, at B. D, E, F, represent small rills

which fill the pool. Now the condition necessary to make the stream issuing at B intermit, is that the capacity of the syphon S be greater than the small rills D, E, F, can supply. If the supply were greater, or exactly equal to the capacity of the syphon, the pool would always be kept full, and of course no intermission could occur. The periods of intermission, as well as the size of the river, depend upon the capacity of the reservoir A, the supply from D, E, F, and the *caliber* of the syphon, S. If it required six days for D, E, F, to fill the pool, and the syphon could exhaust it in one day, you have the conditions required by the statement of Josephus, a river running only on the Sabbath. If D, E, F, fill the pool in one day, and their continued supply is so nearly equal to the draining capacity of the syphon as to require *six* to exhaust it, then you have the river running six days, according to Pliny's account, and resting on the *seventh*. The fact *now* is, if my information be correct, that the supply fills the pool in about two days and a half, and the syphon draws it all off in half a day.

If the account of Josephus was strictly true when he wrote, one of the following changes must have occurred, during the eighteen hundred years that have since elapsed. Either the supply from D, E, F, must have so increased, as to be able to fill the pool in two days and a half, and the capacity of the syphon so enlarged as to exhaust the pool with its triple supply of water in half the time it formerly did; or, the supply, and the capacity of the syphon remaining unchanged, the size of the reservoir must have been reduced to about one third of its ancient dimensions. The former supposition is not probable in itself and is discountenanced by the consideration, that in the time of Josephus the amount of water was so great as to obtain the name of *river*, and it can only claim that title now by courtesy. But we may readily admit that the pool may have been partly filled up by debris, or by the falling in of its superincumbent roof of rock. If Pliny's account were true, then either the supply must be greatly diminished, or the reservoir greatly enlarged, for according to him, it required but one day of rest to fill the pool, while now it takes two days and a half. Either of these hypothetical changes is possible, but neither of them very probable. Nor are we compelled to resort to any of them. I suppose the Sabbatic River was always nearly what we find the stream at *Mar Girgius* now to be. And the vagueness of general rumor, the proverbial love of the

ancients for the marvelous, and the desire to conform this natural phenomenon to the Jewish division of time, will sufficiently account for the statements of these great historians.

The following circumstance corroborates the general correctness of the preceding statements, which were drawn up after my first visit to the convent of St. George in 1840. In October, 1845, I again had occasion to visit the same part of Syria, and had opportunities to make farther inquiries in regard to this remarkable river. Having visited and examined the ruins of the magnificent temple at Arca, I traveled across the country towards the north, along or near to the line of the ancient Roman road, according to the itineraries and old geographers. At length I came to the *dry* channel of a wide stream, coming down from the mountain on which the convent is built. As I expected, the peasants informed me that its source was at the cave below the convent. After traveling two or three hours farther north I crossed another river, called Abrosh, or Leper's River, on the banks of which there is an ancient site, still called Rahanea, which is exactly the Arabic pronunciation of the Raphanea of Josephus.

I spent the night with an old Sheikh of the Ansairiyeh at a village about twenty miles to the west of the convent. The Shiekh was not only acquainted with the fountain, which he called Nebā el Fûār, but immediately gave to the stream itself the name of Nhr Sebty, or *seventh day river*. And he insisted that it ran only once every seven days, although I knew to the contrary. But, in accordance with his own religion, he made it a *moslem*, declaring that it flowed only on *Friday*. From some such Sheikh as this, Josephus (or Titus) may have received his account eighteen centuries ago, as he passed along this road. Nor ought it to be regarded as very wonderful, that traditions should be handed down, in the east, for so many generations, unchanged. We have the very *names* of the places preserved unaltered, and why not the singular tradition connected with them.

My traveling companion on the latter tour, Capt. Newbold of the East India army, subsequently made a visit to the convent of St. George, solely to examine this river. He is fully convinced of its identity with the Sabbatic River of Josephus. He however understood the monks to say that the periods of intermission varied with the rainy and dry seasons of the year. This is very probably correct.

ART. XXIX.—*On Three several Hurricanes of the American Seas and their relations to the Northers, so called, of the Gulf of Mexico and the Bay of Honduras, with Charts illustrating the same;* by W. C. REDFIELD.

(Continued from Vol. II, p. 187.)

*Phenomena of the Cuba Hurricane and Cotemporary Storms.*

EFFECT OF THE GALE'S ROTATION ON THE BAROMETER.—The extraordinary fall of the mercury in the barometer which takes place in gales or tempests, has attracted attention since the earliest use of this instrument by meteorologists. But I am not aware that the principal cause of this depression had ever been pointed out, previously to my first publication in this Journal, in April, 1831; when I took the occasion to notice this result as being obviously due to the *centrifugal force* of the revolving motion found in the body of the storm.*

Since that period, inquiries have been continued by meteorologists in regard to the periodical and other fluctuations of the barometer, and the relations of these fluctuations to temperature and aqueous vapor.† But these incidental causes of variation in the atmospheric pressure prove to be of minor influence, and we are left to the sufficient and only satisfactory solution of this marked phenomenon which is found in the centrifugal force of rotation.

In the Cuba Hurricane, the fall of the barometer may now be viewed in its obvious relations to the known rotation of the gale. In the previous Tables, I, II, and III, the reader may have noticed the depressing effects of the centrifugal force at different distances from the storm's axis and in the various stages of its activity and progression. These tables enable us to determine, approximately, *the mean of the barometric curve, through the central portion of the storm, transversely to its path*, as shown by the lowest observations obtained during its progress, which may be grouped as follows:

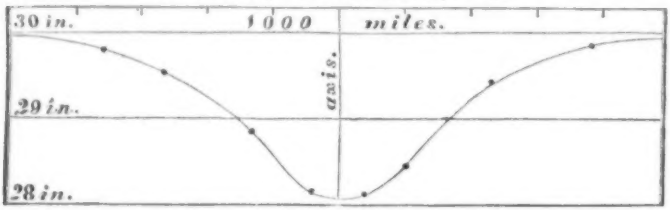
* This Journal, xx, 45–46.

† It is apparent that hygrometrical observations made at the earth's surface cannot show the relative condition of the higher strata of air, which move, as currents, in different directions, with a rapid progression, and have different geographical and hygrometrical relations. Nor can observations at mountain stations resolve the difficulty; for these must commonly have relation to the inferior stratum of air which has ascended the mountain slope.

On the left side of the storm path, the lowest observations found in recitals 45*a*, 75, 97, 106, 109, 114, 126 and 135, at points varying from 305 to 400 miles from the axis line and at an average distance of 349 miles, afford us a mean of 29·76 inches. At most of these points, as at others, the true minimum doubtless occurred between the times of observation, but only in 45*a* is a subtraction of ·12 in. made on this account. Recital 118, at a distance of 260 miles, shows 29·50 in., probably within an hour of the true minimum. Recitals 4, 6, 11*b*, 38, 81, 124, 133, 141, 142 and 144, in positions from 69 to 168 miles from the axis and at an average distance of 126 miles, show an average minimum of 28·84 inches. On the *center path*, as per Chart, the average minimum, as per recitals 34, 51, 148, 129 and 130, is 28·13 inches. On the right hand side of the path, recitals 19 and 64, at a mean of 98 miles from the axis, show an average minimum of 28·45 inches. The *Pioneer* (62) at 230 miles gives 29·45 inches:—and at Bermuda, at 375 miles, being a station where the barometer shows an annual mean of at least 30·16 in., our lowest observation is 29·86 inches. These several elements afford us the approximate curve which is here annexed.

Fig. 5.

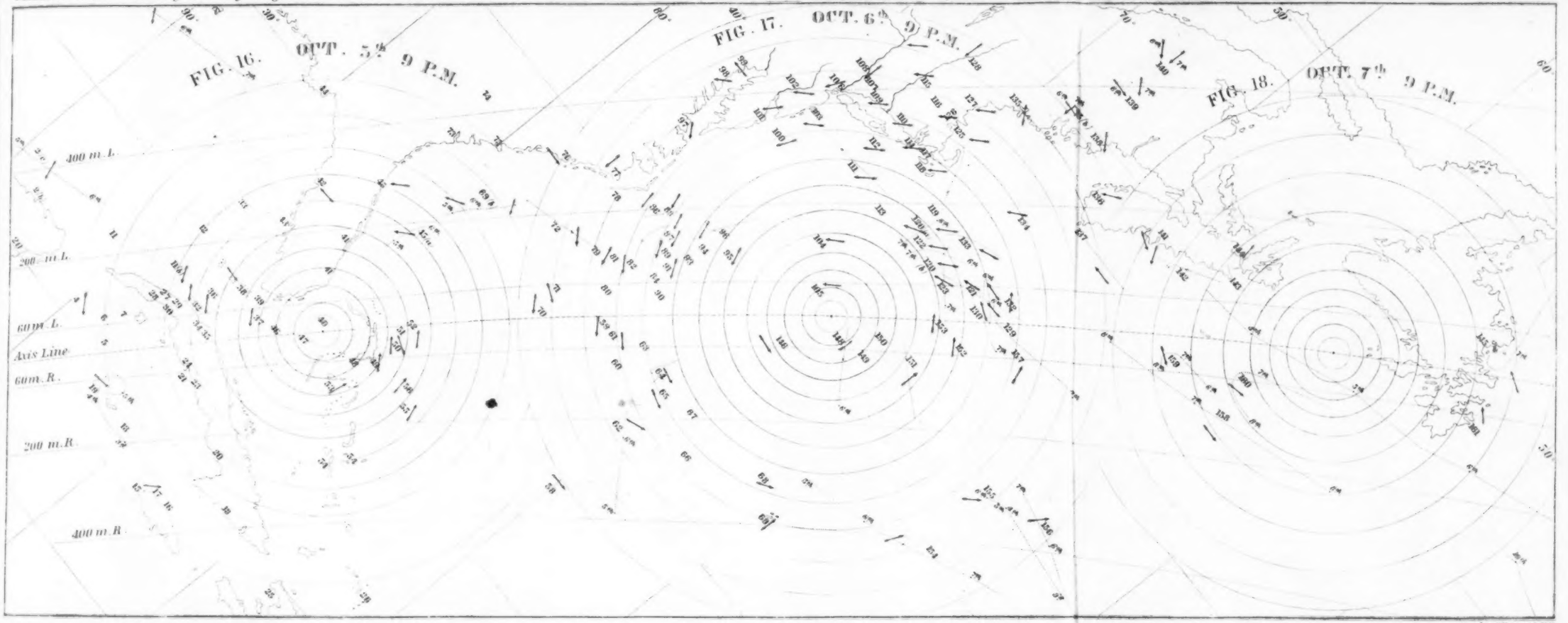
Mean Barometric Curve across the centre of the Cuba Hurricane, transversely to its path, Oct. 4th to 7th, 1844.—Vertical scale, one half.




It is worthy of remark that the barometric depression in this gale does not appear to increase according to the increase of latitude; showing that the proper effects of the centrifugal force of rotation are constantly found on the *center path* of the storm, in all latitudes.

The mean barometric curve on the center path, in the direction of the storm's progression, appears not to differ essentially from that given above, so far as may be inferred from the various observations, except that on the posterior side of the storm the return of pressure, at some places, was apparently more rapid than

CHART IX. *Showing the Daily Progress of the Cuba Hurricane, with the Direction of Wind at the hour of 9 P.M. on the 5th 6th & 7th days of October, respectively. 1844.* CHART IX.




*The numbers show the places of vessels named in the recitals*

Engd by J.M. Atwood N.Y.

its previous reduction. The contrary of this effect is sometimes seen in other storms.*

Thus, during successive days of the storm's greatest activity, and while passing through twenty-five degrees of latitude and near twenty-three degrees of longitude, we find an extraordinary barometric depression, the intensity of which increases rapidly as we approach towards the axial area of this great progressive whirlwind, coinciding, also, most remarkably, with the progress and intensity of the whirling action. We find, too, that the greatest intensity of the hurricane, and of its influence on the barometer, has no necessary connexion, or coincidence, with the local point of greatest rain or condensation; as clearly appears from recitals 38, 148, and other reports. Nor can any such coincidence at all lessen or contravene the known centrifugal force of rotation. To deny the proper influence of this force in rotatory storms, would appear equivalent to a denial of the great law of matter and motion to which the term is applied.

The same law of centrifugal action must tend to produce an accumulation of pressure beyond the verge of the active whirlwind, or at least in the areas or spaces which separate distant storms; a result which we have already viewed, in another connexion, in the two October storms of 1842 and 1837. In the present case, the barometric curve, in front of the hurricane as well as laterally, is found to blend with the more advanced and extended depression of the first Cuba gale;† and if we view the two centers of depression as comprised in one great area of gyrative influence, the accumulated exterior pressure, or summit of the barometric wave, will appear to be strongly exhibited, over a vast extent of surface, previous to the arrival of the storm. This is apparent from the various recitals previously given, and is shown more extensively by the barometric observations comprised in Table IV, which is annexed.

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* It may be noticed that the barometric depression in this gale does not appear to increase according to the increase of latitude; showing, that the proper effects of the centrifugal force of rotation are truly shown in the center path of the storm, in all latitudes.

† See Plate XI, figs. 21 and 22.

**Table IV.**—Height of the Barometer (corrected for elevation) at the hours of 9 A. M. and 9 P. M., or other nearest hours of observation, for seven days in October, 1844; together with the highest and lowest observations made in this period.—In the daily columns, only the excess of 28 inches is noted, 2 inches being thus the equivalent of 30 inches of the barometric scale.

| Places, numbered for order of progression. | Dist.fr. axis l. | Lat. | Lon. | Feet ab.tide | Oct. 1st. | | Oct. 2d. | | Oct. 3d. | | Oct. 4th. | | Oct. 5th. | | Oct. 6th. | | Oct. 7th. | | Lowest obs. | | Rain. | Inches. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | A. M. | P. M. | A. M. | P. M. | A. M. | P. M. | A. M. | P. M. | A. M. | P. M. | A. M. | P. M. | A. M. | P. M. | 1st g. | 2d g. | | |
| Fort Snelling (15) | 1350 | 44° 53′ | 93° 08′ | 850 ft. | 2·18 | 2·12 | 2·12 | 2·07 | 2·05 | 2·05 | 2·10 | 2·03 | 2· | 2·05 | 2·16 | 2·16 | 2·21 | 2·05 | 29·98 | 30·03 | None | |
| Fort Crawford (14) | 1290 | 43 3 | 90 53 | 642 | 2·28 | 2·29 | 2·20 | 2·14 | 2·07 | 2·01 | 2·08 | 2·06 | 2·03 | 2·06 | 2·16 | 2·16 | 2·23 | 2·23 | 30·04 | 30·06 | None | |
| Fort Gibson (10) | 1160 | 35 47 | 95 10 | 600 ? | 2·30 | 2·27 | 2·30 | 2·23 | 2·28 | 2·17 | 2·13 | 2·06 | 2·07 | 2·03 | 2·04 | 2·05 | 2·22 | 2·22 | 30·05 | 30·03 | None | |
| Fort Towson (9) | 1090 | 33 33 | 95 05 | 600 ? | 2·19 | 2·20 | 2·22 | 2·15 | 2·18 | 2·01 | 2·05 | 1·95 | 1·96 | 1·80 | 1·93 | 1·86 | 2·06 | 2·10 | 29·92 | 29·80 | None | |
| Fort Brady (20) | 1040 | 46 30 | 84 43 | 600 | 2·37 | 2·39 | 2·04 | 1·78 | 1·62 | 1·74 | 1·93 | 1·95 | 1·91 | 2· | 2·20 | 2·16 | 2·19 | 2·06 | 29·61 | 30·16 | 2–3d, | ·46 in. |
| Jeff. Barracks (13) | 990 | 38 28 | 80 08 | 390 | 2·38 | 2·25 | 2·29 | 2·16 | 2·12 | 2·01 | 2·05 | 2·01 | 2·06 | 1·93 | 2·05 | 2·12 | 2·28 | 2·23 | 29·95 | 30·03 | None | |
| Fort Jessup (7) | 885 | 31 30 | 93 47 | 270 ? | 2·17 | 2·22 | 2·15 | 2·12 | 2·17 | 2·14 | 2·21 | 2·14 | 2·14 | 2·11 | 2·15 | 2·15 | 2·12 | 2·11 | 30·13 | 30·13 | None | |
| Natchez (8) | 850 | 31 34 | 91 25 | 270 | 2·34 | 2·25 | 2·27 | 2·25 | 2·18 | 2·08 | 2·06 | 1·93 | 2· | 1·98 | 1·94 | 1·93 | 2·16 | 2·20 | 29·99 | 29·89 | None | |
| Detroit (17) | 800 | 42 24 | 82 28 | 580 | 2·32 | 2·31 | 2·23 | 2·03 | 1·89 | 1·83 | 1·95 | 1·93 | 1·99 | 2·01 | 2·10 | 2·12 | 2·12 | 2·15 | 29·83 | 30·12 | 2–4th, | ·15 |
| N. Orleans Bar. (6) | 730 | 29 57 | 90 05 | | 2·32 | 2·31 | 2·29 | 2·26 | 2·16 | 2·13 | 2·05 | 2·03 | 2·03 | 2·01 | 2·10 | 2·02 | 2·32 | 2·25 | 30·03 | 30·01 | None | |
| Toronto Obs. (21) | 700 | 43 39 | 79 21 | 342 | 2·46 | 2·36 | 2·22 | 1·91 | 1·75 | 1·70 | 1·69 | 1·67 | 1·79 | 1·87 | 2·05 | 2·03 | 2·11 | 2·10 | 29·66 | 30·03 | 2–3d, rain | |
| Buffalo (19) | 660 | 42 53 | 78 56 | 620 | 2·27 | 2·43 | 2·36 | 2·13 | 2·92 | 1·79 | 1·84 | 1·76 | 1·86 | 1·95 | 2·08 | 2·10 | 2·14 | 2·10 | 29·76 | 30·10 | 2–4th, | ·46 |
| Rochester (22) | 635 | 43 08 | 77 51 | 506 | 2·34 | 2·37 | 2·36 | 2·26 | 2·13 | 1·96 | 1·76 | 1·62 | 1·75 | 1·83 | 1·92 | 1·79 | 1·90 | 2·11 | 29·62 | 29·79 | 2–5th, | ·76 |
| Fort Barrancas (5) | 620 | 30 18 | 87 12 | | 2·20 | 2·17 | 2·19 | 2·23 | 2·16 | 2·07 | 2·07 | 2·01 | 2·02 | 2·07 | 1·99 | 2·03 | 2·08 | 2·08 | 30·03 | 29·96 | nt. 6th, | ·30 |
| Sackett's Harbor (24) | 580 | 43 57 | 76 04 | 240 | 2·43 | 2·37 | 2·33 | 2·13 | 2·03 | 1·89 | 1·79 | 1·60 | 1·63 | 1·94 | 2·11 | 2·11 | 2·10 | 2·13 | 29·60 | 30·10 | 3–5th, | ·85 |
| Plattsburgh Bar. (31) | 520 | 44 41 | 73 26 | 240 ? | 2·39 | 2·35 | 2·42 | 2·39 | 2·03 | 1·91 | 1·77 | 1·78 | 1·60 | 1·73 | 2·01 | 2·03 | 2·19 | 2·19 | 29·60 | 30·03 | 3–5th, | 1·18 |
| Carlisle Bar. (18) | 430 | 40 12 | 77 10 | 473 | 2·45 | 2·50 | 2·41 | 2·29 | 2·11 | 1·94 | 1·84 | 1·78 | 1·78 | 2·01 | 2·13 | 2·05 | 2·05 | 2·16 | 29·76 | 30·05 | 3d, | 1·55 |
| Augusta Ars. (12) | 470 | 33 27 | 81 35 | 370 | 2·23 | 2·24 | 2·25 | 2·20 | 2·15 | 2·10 | 2·04 | 1·90 | 1·92 | 1·93 | 1·99 | 1·92 | 1·94 | 2·15 | 29·90 | 29·90 | None | |
| Hanover, N. H. (30) | 460 | 43 41 | 72 22 | 350 | 2·40 | 2·50 | 2·48 | 2·28 | 2·16 | 2· | 1·80 | 1·51 | 1·60 | 1·84 | 1·98 | 1·96 | 1·99 | 2·11 | 29·51 | 29·85 | 3–4th, | 2·85 |
| H. M. S. *Pique*,* (35) | 415* | 49 35 | 64 30 | | | | | | 2·24 | 2·19 | 2·18 | 2·02 | 1·36 | 1·19 | 1·40 | 1·90 | 1·50 | 1·19 | 29·16 | 29·19 | 5th, *r.*; 7th, *r.* | |
| Amherst, Mss. (27) | 410 | 42 22 | 72 28 | 200 | 2·44 | 2·42 | 2·47 | 2·35 | 2·22 | 2·10 | 1·82 | 1·69 | 1·64 | 1·83 | 2·02 | 2·02 | 1·99 | 2·10 | 29·62 | 29·92 | 3–4th, | 1·98 |
| New York (23) | 400 | 40 43 | 74 01 | | 2·53 | 2·48 | 2·49 | 2·34 | 2·17 | 1·94 | 1·73 | 1·60 | 1·82 | 1·89 | 2·06 | 1·84 | 2·05 | 2·18 | 29·66 | 29·84 | 4th, slight *r.* | |
| Worcester (28) | 375 | 42 16 | 71 47 | 376 | | | 2·40 | 2·28 | 2·03 | 1·99 | 1·70 | 1·47 | 1·53 | 2·07 | 1·80 | 1·84 | 1·73 | 1·94 | 29·35 | 29·61 | 3–4th, 2·49; 7th, ·21 | |
| Hamden, Me. (32) | 365 | 44 42 | 68 56 | 180 | | | 2·49 | 2·60 | 2·43 | 2·30 | 2·08 | 1·50 | 1·49 | 1·68 | 2·03 | 2·04 | 1·85 | 2·14 | 29·47 | 29·85 | 4th, ·95; 7th, ·54 | |
| Boston (29) | 345 | 42 20 | 71 05 | | 2·30 | 2·34 | 2·40 | 2·31 | 2·20 | 1·96 | 1·90 | 1·48 | 1·55 | 1·79 | 1·92 | 1·79 | 1·83 | 2·03 | 29·47 | 29·79 | 4th, 1·34; 7th, ·74 | |
| Fort Monroe (16) | 345 | 37 02 | 76 12 | | 2·61 | 2·55 | 2·53 | 2·55 | 2·22 | 1·99 | 1·87 | 1·81 | 2·06 | 2·07 | 2· | 1·86 | 2·16 | 2·28 | 29·81 | 29·82 | None (?) | |
| Charleston, S. C. (11) | 335 | 32 46 | 79 46 | | 2·35 | 2·40 | 2·35 | 2·25 | 2·11 | 2· | 1·90 | 1·85 | 1·95 | 2· | 1·80 | 1·95 | 2·10 | 2·20 | 29·85 | 29·80 | None | |
| Fort Adams, R. I. (25) | 325 | 41 28 | 71 23 | | 2·41 | 2·44 | 2·47 | 2·33 | 2·21 | 2· | 1·68 | 1·60 | 1·64 | 1·84 | 1·93 | 1·79 | 1·83 | 2· | 29·60 | 29·77 | 4th, 2·1; 7th, 1· | |
| Fort Brooke, Fl. (3) | 305 | 27 57 | 82 35 | | 2·61 | 2·61 | 2·16 | 2·16 | 2·07 | 2·03 | 1·94 | 1·95 | 1·89 | 1·79 | 1·86 | 1·94 | 2·07 | 2· | 29·93 | 29·79 | 2d, | ·10 |
| St. Augustine (4) | 305 | 29 40 | 81 35 | | 2·18 | 2·22 | 2·18 | 2·18 | 2·16 | 2· | 1·92 | 1·86 | 1·91 | 1·83 | 1·85 | 2·10 | 2·13 | 2·10 | 29·86 | 29·75 | 5th, rain | |
| Nantucket (26) | 260 | 41 15 | 70 06 | | 2·30 | 2·30 | 2·29 | 2·27 | 2·15 | 2· | 1·55 | 1·50 | 1·56 | 1·58 | 1·85 | 1·85 | 1·70 | 1·85 | 29·59 | 29·59 | 4th, shs.; 6–7th, 1·50 | |
| Halifax (flag sh.) (33) | 168 | 44 36 | 63 28 | | | | | | | 2·19 | 2·09 | 1·92 | 1·54 | 1·55 | 1·73 | 1·80 | 1·50- | 1·59 | 29·48 | 29·23 | 4–5th, *r.*; 7th, *r.* | |
| H. M. S. *Scylla* (34) | 132 | 44 21 | 63 ? | | | | 3·20 | | 2·40 | | 2·20 | | 1·30 | | 1·75 | | 0.90 | | 29·30- | 28·90 | 4th, *r.*; 7th, *r.* | |
| Key West (2) | 120 | 24 27 | 81 50 | | 2·13 | 2·08 | 2·04 | 2· | 1·97 | 1·93 | 1·87 | 1·82 | 1·51 | 1·59 | 1·93 | 2·16 | 2·18 | 2·22 | 29·93 | 29·13 | 2–5th, | 13·59 ! |
| Matanzas (1) | 50 | 23 03 | 81 15 | | 1·60 | | | | 1· | | 1· | | 0· | | 1·80 | | | | 29· in. | 28· in. | 4–5th, heavy r. | |

* The *Pique's* position in the *second* gale was about 130 miles left of the axis line, in lon. 61° 18′.

This table is taken from a fuller one, so as to suit the dimensions of the printed page; and the field of observation will be seen to comprise a breadth of thirteen hundred and fifty miles on the left side of the axis path of the hurricane. An approximate correction has been made for the known or supposed elevation of the stations in the interior, at the assumed rate of one tenth of an inch of mercury for ninety feet. The places stand in the order of distance from the axis line, beginning with the most remote; and the order of succession in the storm's course, parallel to this line, is indicated by the numbers affixed in the first column. As there is room for but two daily observations, those of the military posts are given for 9 A. M. and 9 P. M., as dividing the time into equal periods, and in other reports the times nearest to these hours are taken. The Toronto observations, only, are reduced for temperature to 32° Fahr.

The observations made at Bermuda, Newfoundland, and on board the *Trent*, (2*c*) at Vera Cruz, and the *Prince Albert*, (164) in lon. 38° 30′, (the latter being six hundred and fifty miles to the right of the axis line,) should also be included with those in the table.* Our barometrical survey is thus extended to two thousand miles, laterally to the path of the hurricane, and over more than thirty degrees of latitude, and fifty-six degrees of longitude.

During the progress of the two associated Cuba storms they are seen to have been immediately preceded, over this vast field, by a barometric wave or accumulation of pressure, rising above the usual or annual mean. An approach to this condition is seen

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* The observations at St. John's, Newfoundland, are entitled to an additive correction of 16 in. for 140 feet of elevation. The elevation of the barometer at Bermuda is not known; but another barometer, observed by an officer at the naval station, ranged from 30·46, on the 1st of October, to 30·07 on the 4th. Winds S. S. E. veering to W. S. W. on the 4th and 5th; and S. S. E. veering to W. on the 6th and 7th.

The importance of establishing a station for meteorological observations at Bermuda, like those which have been instituted by the liberal enterprise of the British government at various other points, appears enhanced by the favorable character of this position, in the open sea, free from all continental and important local influences, and so nearly on the line of equal division between the polar and equatorial areas of the earth's surface. Perhaps the great height of the barometer at Bermuda, and the characteristics of the winds at that place, when these are accurately determined, may afford some additional knowledge of the laws of atmospheric circulation and distribution.

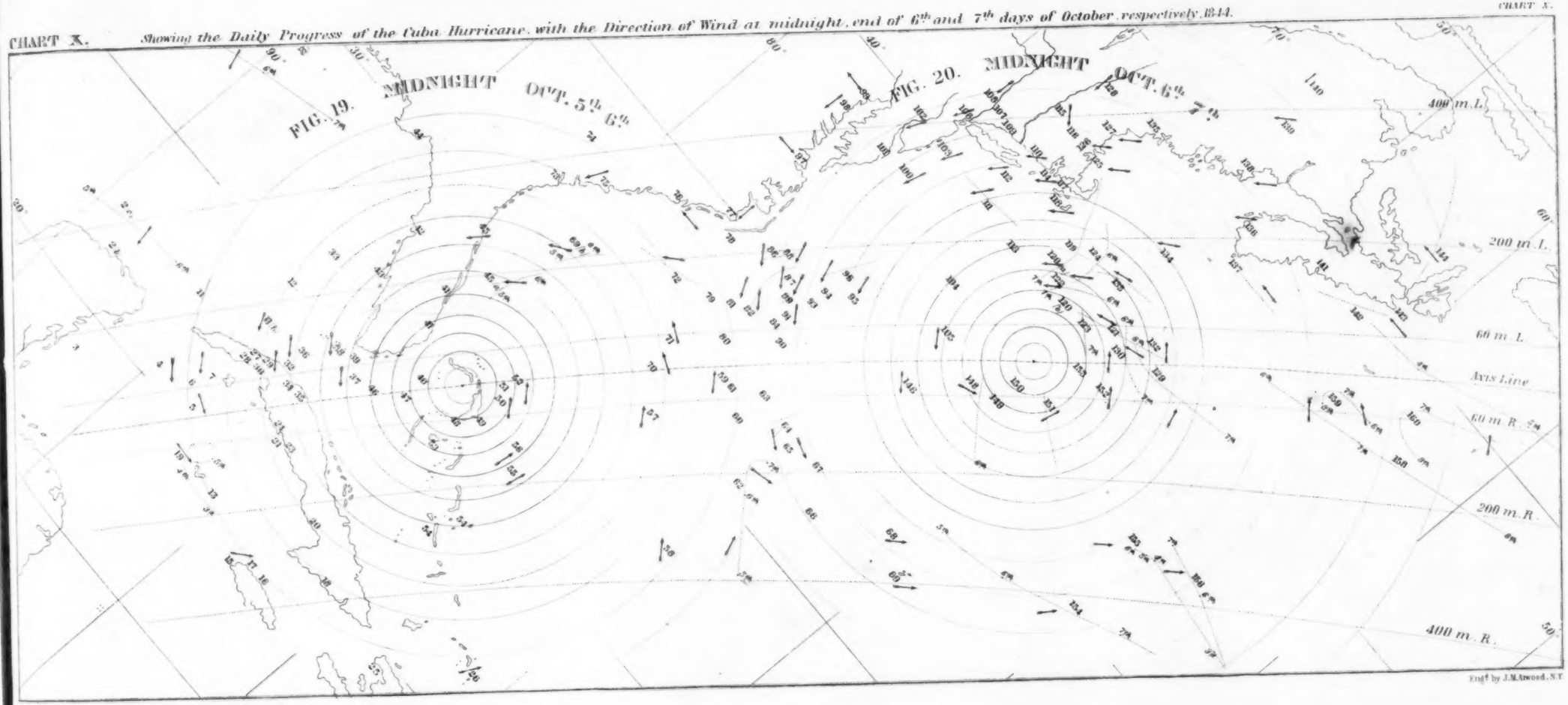
also on the left flank of the two storms, and in the rear of the hurricane. But the decided inequality which thus appears in the wave of maximum pressure in front of these storms as compared with their left border, together with the early disappearance of any excess on this border, in the Atlantic states, after crossing the thirty-first parallel of latitude, will be understood better when we take into view *another storm* which this extended inquiry brings to our notice. I will only remark here, that the areas or waves of cumulated pressure which are thus found between distant storms, as well as the gyrative character of the storms and their extensive barometrical depressions, appear entitled to special consideration in estimating, relatively, the mean barometrical conditions of different zones of the same polar hemisphere.

Cotemporary Storm of the Great Lakes.—The inspection of Table IV and other observations leads me to notice another storm, as above mentioned, the central portions of which passed over the basin of the great American lakes, and the St. Lawrence, cotemporaneously with the progress of the first Cuba gale. The first decided barometric indication of this storm, we obtain at Fort Brady, at the outlet of Lake Superior, on the 2d of October; from whence, advancing at the rate of about twenty-two miles an hour, we find its influence extending over the northern parts of the United States, Canada, and Nova Scotia, crossing the Gulf of St. Lawrence, and coinciding in part, with the phenomena of the first Cuba storm.* Its action, though widely extended, appears at first to have been moderate; and it was accompanied with light rain, which extended over Michigan and a part of Ohio, Pennsylvania, New York, and a large portion of the New England states. As the storm advanced in its course, its activity appears to have increased, and its barometric curve, blended with that of the first Cuba storm, becomes deeper, and, after a partial rising, is found to merge in the marked depression which attended the Cuba hurricane.

We may suppose that these different storms continued to pursue their several distinct courses, each crossing obliquely the path of another. Perhaps, too, the progress of this storm from the lakes might avail us in explaining more perfectly the origin of

* The effects of this storm on the southern borders of Lake Michigan were noticed in the newspapers of that period.

CHART X. *Showing the Daily Progress of the Cuba Hurricane, with the Direction of Wind at midnight, end of 6th and 7th days of October respectively, 1844.*




Engd by J.M.Atwood. N.Y.

*The numbers show the places of vessels named in the recituls.*

the group of storms which appeared on the European coasts about the 10th of October.

Local Curves of Pressure during the Progress of the several Storms.—The barometric observations at various points on or contiguous to the track of the Cuba hurricane from the 1st to the 7th or 8th of October, in the order of distance from its center-path, are delineated on Plate XI, fig. 21. This order of axial distance cannot be combined with that of the storm's progression, but the latter order is indicated by the numbers annexed to the several places of observation. The rising of the barometer, after its depression in the first Cuba storm and that of the lakes, is here seen to have been interrupted or prevented by the depressive effect of the hurricane which followed. In the first storm the fall of the barometer is seen to increase, northward of the Carolinas, in approximating with the route and the wide spreading influence of the storm from the basin of the great lakes, so that from New York to the mouth of the St. Lawrence the barometric depression was greater than was subsequently found in the left margin of the succeeding hurricane. In fig. 22, Plate XI, the same barometric curves are all adjusted to one point of advance in the Cuba hurricane, for the purpose of facilitating the comparisons. The several distances from the axis line are noted in the right hand column.

The importance of these extended observations, as affording some explanation of the causes and character of the irregular barometric undulations which occur in temperate latitudes, induces me to exhibit, in fig. 23, Plate XI, a delineation of the local curves in the track of the *third* or Lake storm; showing, as we approach the seaboard, the united barometrical effects of at least two storms as they are found converging in their course. The distances of the several places of observation from Halifax are noted on the Plate, beginning at Lake Superior. The route of this Lake storm appears to have been nearly parallel to that of the storm of Nov. 11th, 1835; which is found on Chart I, marked XI.

Thus it appears that two different storms may at one period in the course of their progression, be found moving in the same geographical area, even when their several places of origin have been greatly distant from each other. Their convergence in such cases, may result from different courses of progression, as well as

from the convergence of the lines of longitude at increased distances from the equator, and may be aided in some degree by the greater horizontal expansion or diffusion of the several storms which is often found to take place in the higher latitudes.

Distribution of Temperature during the Storms.—Though unable to detect any controlling or characteristic influence of temperature in the development or progression of great storms, other than is involved in the induced or the incidental phenomena of these storms, I present here a summary view of the thermometric observations made in the extensive region under review, during the observed progress of the two Cuba storms. So many of the observations obtained as can be comprised on a single page are shown in Table V, which follows:—(See page 319.)

In presenting the observations from the military posts, in this table, I have taken those of sunrise and 3 P. M. because they are accompanied by observations of the wet bulb thermometer; although the observations made at 9 A. M. and 9 P. M. might afford better indications of the thermometric effects induced by, or attending, the storm. The observations from other places, when taken at 6 A. M. are deemed as nearly equivalent to those for sunrise at the beginning of October, and those for 2 P. M. or 2·30 as being sufficiently accordant with those made at 3 P. M. The observations made at other hours are so specified in the first columns of the table.

Temperature of Winter Storms.—If there be any appreciable results shown in Table V, they are perhaps found in a slight reduction of the local temperature in the areas of the two Cuba storms, while south of Cape Hatteras, and an increase of the local temperature when in the higher latitudes, as also in the storm from the lake basin. In colder months, and particularly in the winter season, a marked increase of temperature in the heart of the storm is commonly observed in the United States and Canada. This increase appears to result, mainly, from the geographical distribution of temperature in the different seasons and from the revolving and progressive character of the several storms. For it will readily be seen, that on the approach of a great storm from the lower latitudes by the usual routes, while revolving from right to left, ↻, its first effect will be to bring in the warm and humid air of a more southern region; and when the axis of the gale has passed, the contrary result necessarily follows and is in-

TABLE V.—Showing the state of the Thermometer at 6 A. M., (or at sunrise,) and at 3 P. M., with the daily mean, from the 1st to the 8th of October, inclusive, 1844; with some observations at other hours, as indicated in the body of the table.

| Places. | Oct. 1st. | | | | Oct. 2d. | | | | Oct. 3d. | | | | Oct. 4th. | | | | Oct. 5th. | | | | Oct. 6th. | | | | Oct. 7th. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sun r. | 3 P.M. | Daily mean. | Wet bulb. | Sun r. | 3 P.M. | Daily mean. | Wet bulb. | Sun r. | 3 P.M. | Daily mean. | Wet bulb. | Sun r. | 3 P.M. | Daily mean. | Wet bulb. | Sun r. | 3 P.M. | Daily mean. | Wet bulb. | Sun r. | 3 P.M. | Daily mean. | Wet bulb. | Sun r. | 3 P.M. | Daily mean. | Wet bulb. |
| | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° |
| Fort Snelling | 44 | 63 | 56 | 43 | 57 | 48 | 64 | 56 | 48 | 50 | 44 | 59 | 51·5 | 41 | 50 | 34 | 58 | 46 | 34 | 50 | 39 | 57 | 48 | 39 | 57 | 36 | 62 | 49 | 36 | 52 | 37 | 67 | 52 | 37 | 55 |
| Fort Crawford | 45 | 70 | 57·2 | 42 | 57 | 56 | 59 | 62 | 53 | 60 | 47 | 60 | 53·2 | 44 | 59 | 43 | 62 | 52·2 | 41 | 57 | 42 | 60 | 51 | 40 | 57 | 41 | 58 | 49·2 | 40 | 55 | 39 | 64 | 51·2 | 40 | 55 |
| Fort Gibson | 54 | 77 | 65·1 | 50 | 67 | 64 | 82 | 73·1 | 60 | 70 | 53 | 79 | 66·5 | 50 | 65 | 49 | 85 | 67·2 | 46 | 74 | 57 | 81 | 69·2 | 55 | 71 | 47 | 76 | 61·5 | 44 | 63 | 58 | 74 | 66·2 | 51 | 66 |
| Fort Towson | 51 | 75 | 63 | 45 | 46 | 61 | 77 | 64 | 59 | 68 | 56 | 82 | 69 | 55 | 67 | 45 | 83 | 64 | 42 | 44 | 48 | 88 | 68 | 42 | 50 | 50 | 83 | 66·5 | 44 | 50 | 55 | 71 | 63 | 48 | 42 |
| Fort Brady | 34 | 59 | 46·5 | 34 | 55 | 50 | 57 | 53·5 | 50 | 55 | 44 | 52 | 48 | 44 | 51 | 46 | 51 | 48·5 | 45 | 49 | 45 | 48 | 46·5 | 44 | 45 | 34 | 50 | 42 | 34 | 46 | 30 | 55 | 42·5 | 30 | 50 |
| Jeff. Barracks | 54 | 64 | 59 | 50 | 54 | 61 | 72 | 66·5 | 55 | 63 | 55 | 70 | 62·5 | 48 | 56 | 51 | 64 | 57·5 | 43 | 55 | 47 | 63 | 55 | 39 | 55 | 53 | 70 | 61·5 | 48 | 63 | 48 | 60 | 54 | 40 | 52 |
| Fort Jessup | 42 | 68 | 55 | 36 | 60 | 43 | 67 | 55 | 40 | 60 | 41 | 84 | 67·6 | 45 | 75 | 52 | 85 | 68·5 | 46 | 76 | 61 | 82 | 71 | 54 | 78 | 62 | 88 | 75 | 54 | 80 | 55 | 69 | 62·5 | 48 | 62 |
| Natchez | 55 | 66 | (*noon*) | | | 59 | 71 | | | | 64 | 73 | | | | 63 | 71 | | | | 58 | 70 | | | | 56 | 77 | | | | 58 | 69 | | | |
| Detroit | 42 | 70 | 56 | 40 | 50 | 50 | 64 | 57 | 47 | 58 | 46 | 54 | 50 | 43 | 50 | 46 | 56 | 51 | 44 | 52 | 45 | 58 | 51·5 | 42 | 51 | 46 | 62 | 54 | 42 | 56 | 33 | 68 | 51·5 | 31 | 60 |
| New Orleans | 55 | 78 | 66·5 | 51 | 68 | 59 | 82 | 70·5 | 54 | 71 | 60 | 82 | 71 | 55 | 71 | 63 | 82 | 72·5 | 56 | 61 | 53 | 77 | 65 | 49 | 64 | 56 | 79 | 67·8 | 53 | 66 | 65 | 79 | 72 | 59 | 69 |
| Toronto Obs.† | 31 | 55 | 45 | 34 | 48 | 41 | 60 | 52·4 | 41 | 57 | 44 | 60 | 54 | 44 | 55 | 44 | 54 | 50·4 | 43 | 51 | 48 | 52 | 48.8 | 46 | 47 | 48 | 67 | 57·5 | 43 | 50 | 33 | 47 | 39·2 | 32 | 42 |
| Buffalo | 31 | 62 | 46·5 | 31 | 62 | 43 | 68 | 55·5 | 42 | 67 | 56 | 64 | 60 | 56 | 63 | 47 | 61 | 54 | 46 | 60 | 43 | 54 | 48·5 | 43 | 53 | 41 | 54 | 47·5 | 62 | 53 | 40 | 43 | 44 | 40 | 47 |
| Pittsburgh Ars. | 44 | 64 | 54 | 43 | 56 | 45 | 64 | 54·5 | 14 | 56 | 55 | 64 | 57·5 | 54 | 57 | 44 | 55 | 49·5 | 44 | 42 | 48 | 59 | 53·5 | 46 | 53 | 48 | 55 | 51·5 | 53 | 46 | 40 | 55 | 47·5 | 38 | 49 |
| Pensacola | 58 | 84 | 71 | 54 | 64 | 62 | 82 | 72 | 58 | 70 | 62 | 78 | 70 | 58 | 70 | 62 | 84 | 73 | 58 | 60 | 52 | 82 | 67 | 52 | 66 | 52 | 74 | 63 | 50 | 58 | 60 | 78 | 69 | 56 | 60 |
| Sackett's Harbor | 26 | 54 | 40 | 25 | 52 | 30 | 64 | 47 | 30 | 63 | 50 | 56 | 53 | 50 | 55 | 53 | 57 | 55 | 52 | 55 | 49 | 52 | 50·5 | 40 | 52 | 42 | 46 | 44 | 41 | 44 | 42 | 50 | 48·5 | 42 | 50 |
| Plattsburgh | 50 | 62 | 56 | 46 | 57 | 55 | 68 | 61·5 | 52 | 64 | 44 | 60 | 52 | 42 | 58 | 52 | 64 | 58 | 50 | 61 | 48 | 59 | 53·5 | 46 | 57 | 46 | 56 | 51 | 43 | 53 | 34 | 50 | 42 | 31 | 46 |
| Carlisle Bar. | 54 | 65 | 54·5 | 44 | 57 | 56 | 64 | 60 | 46 | 56 | 56 | 68 | 62 | 47 | 54 | 62 | 64 | 63 | 54 | 56 | 54 | 68 | 61 | 42 | 58 | 53 | 64 | 58·5 | 46 | 56 | 46 | 56 | 51 | 44 | 48 |
| Augusta Ars. | 52 | 72 | 62 | 51 | 64 | 60 | 76 | 68 | 58 | 70 | 64 | 79 | 71·5 | 60 | 71 | 65 | 73 | 69 | 64 | 55 | 56 | 72 | 64 | 55 | 67 | 56 | 70 | 63 | 55 | 65 | 55 | 74 | 64·5 | 54 | 64 |
| Hanover, N. H. | 30 | 60 | (1·30 P. M.) | | | 21 | 58 | " | | | 43 | 56 | " | | | 52 | 54 | " | | | 49 | 59 | " | | | 15 | 52 | " | | | 42 | 46 | " | | |
| H. M. S. *Pique* | | | | | | | | | | | 9A.M.50·5 | 9P.M.56 | | | | 9A.M.53 | 8P.M.56.5 | | | | 9A.M.55 | 3P.M.57 | | | | 9A.M.54 | 3P.M.55 | | | 8A.M.56 | 3P.M.57 | | | |
| Amherst, Mss. | 29 | 54 | 41·5 | | | 26 | 58 | 42 | | | 44 | 61 | 52·5 | | | 55 | 63 | 59 | | | 43 | 55 | 49 | | | 37 | 51 | 44 | | | 43 | 50 | 46·5 | | |
| New York* | 48 | 62 | 55 | 44 | 52 | 50 | 63 | 56.5 | 49 | 56 | 54 | 65 | 59·5 | 52 | 62 | 60 | 67 | 63.5 | 58 | 63 | 52 | 65 | 58·5 | 49 | 61 | 50 | 56 | 53 | 44 | 56 | 48 | 55 | 51·5 | 47 | 50 |
| Worcester | | | | | | 29 | 69 | (2 P. M.) | | | 42 | 58 | 50 | | | 58 | 66 | 62 | | | 46 | 60 | 53 | | | 43 | 57 | 50 | | | 43 | 50 | 46·5 | | |
| Hamden | | | | | | 27 | 50 | 38·7 | | | 43 | 51 | 47·7 | | | 54 | 58 | 55·7 | | | 53 | 60 | 54·7 | | | 46 | 55 | 49·7 | | | 43 | 43 | 42·2 | | |
| Boston | 40 | 56 | 48 | | | 36 | 57 | 46·5 | | | 49 | 61 | 55 | | | 59 | 64 | 61·5 | | | 59 | 63 | 61 | | | 48 | 51 | 49·5 | | | 46 | 52 | 49 | | |
| Fort Monroe | 53 | 68 | 60·5 | 51 | 61 | 63 | 68 | 65·5 | 58 | 65 | 64 | 69 | 66·5 | 61 | 63 | 62 | 69 | 65·5 | 59 | 64 | 58 | 68 | 63 | 56 | 60 | 64 | 64 | 64 | 59 | 60 | 54 | 66 | 60 | 53 | 58 |
| Charleston, S. C. | 60 | 73 | 66·5 | 55 | 64 | 67 | 75 | 71 | 60 | 66 | 69 | 73 | 71 | 64 | 65 | 67 | 75 | 61 | 62 | 59 | 60 | 71 | 65·7 | 53 | 59 | 62 | 72 | 67 | 54 | 59 | 67 | 73 | 70 | 58 | 63 |
| Fort Adams | 45 | 56 | 50·5 | 43 | 51 | 46 | 57 | 51·5 | 45 | 52 | 53 | 60 | 51·5 | 51 | 58 | 61 | 68 | 64·5 | 61 | 63 | 54 | 64 | 59 | 52 | 59 | 52 | 60 | 56 | 50 | 55 | 45 | 56 | 50·5 | 45 | 51 |
| Fort Brooke | 68 | 75 | 71·5 | 65 | 72 | 73 | 80 | 76·5 | 70 | 76 | 72 | 80 | 76 | 70 | 75 | 73 | 78 | 75·5 | 71 | 74 | 71 | 74 | 72·5 | 68 | 70 | 67 | 75 | 71 | 64 | 71 | 59 | 80 | 69·5 | 58 | 76 |
| St. Augustine | 74 | 78 | 76 | 72 | 76 | 76 | 77 | 76·5 | 73 | 75 | 74 | 80 | 77 | 72 | 77 | 70 | 79 | 74·5 | 67 | 72 | 71 | 74 | 72·5 | 68 | 73 | 64 | 74 | 69 | 62 | 70 | 64 | 73 | 68·5 | 57 | 70 |
| Nantucket | 52 | 54 | 9 A. M. & | | | 53 | 59 | | | | 59 | 60 | | | | 61 | 64 | | | | 61 | 60 | | | | 59 | 61 | | | | 48 | 52 | | | |
| Halifax† | | | 3 P. M. | | | | | | | | | | | | | 52 | 58 | 54·5 | | | 59 | 62 | 54·2 | | | 54 | 62 | 55·7 | | | 50 | 49 | 48 | | |
| H. M. S. *Scylla* | | (noon only) | | | | | 52 | | | | | 54 | | | | | 56 | | | | | 62 | | | | | 60 | | | | 56 | | | |
| Key West | 79 | 83 | 81 | 76 | 80 | 78 | 78 | 78 | 76 | 76 | 79 | 78 | 78·5 | 78 | 76 | 76 | 75 | 75·5 | 75 | 75 | 73 | 72 | 72·5 | 75 | 72 | 76 | 79 | 77·5 | 72 | 73 | 72 | 84 | 78 | 65 | 77 |

* At Fort Columbus.

† Observations taken every two hours, night and day; and the daily mean of the whole is given; but at all other places the daily mean as between 9 A. M. and 3 P. M. is copied, and appears not always correct.

creased, apparently, by the subsidence or vorticular depression of the higher and colder currents on the posterior or western side of the gale. Indeed, this rising of the thermometer during the access of winter storms, and its great depression as they pass off in their northeasterly courses, might in itself afford us good proof of the storm's rotation, were more direct evidence wanting.

In summer, when the geographical distribution of temperature on the path of the storm is more equal, the case is greatly altered, and a sinking of the thermometer is not unfrequently noticed in the earlier portions of the storm. The mean temperature of the several storms, is then often below that of the periods between the storms. Thus, while the general course and revolving character of North American storms, at all seasons of the year, are essentially the same, the phenomena and ranges of their temperatures are greatly varied in the different seasons.

Winds of the two Precursory Storms.—The axis of the first Cuba gale, in its early progress, seems to have advanced on a more inflected route than that of the subsequent hurricane, and having passed to the southward and westward of the island of Jamaica, it appears to have crossed the north shore of Cuba at some point eastward of long. 80°. It seems to have partially abated in its visible force in approaching the parallel of 30°, at least on its left and central portions, till it arrived near lat 40°, from whence onward it appears increasing in activity and extension. Its revolving character, when below the tropics, seems fully made out by observations on its different sides; and, during its course in higher latitudes, its right hand portion presents nearly the same winds and consecutive changes that characterized the like portion of the Cuba hurricane. Its more central portions also, exhibited southeasterly winds, followed in the higher latitudes by northwesterly; while, in the eastern states of the American Union, its northerly winds appear to have been partly intercepted by the passing storm from the lakes, and by the closely following hurricane; a result which I have several times observed, in similar cases.

In regard to the winds of the Lake storm, it may suffice to notice that they were chiefly southeasterly in the earlier part of the storm, in the basin of the great Lakes, and northwesterly or northerly during its later periods;—sometimes strong, and at other times weak and fluctuating in direction. At Plattsburgh, a gale

# BAROMETRIC CURVES AS OBSERVED IN THE STORMS OF OCTOBER 1842.



Fig.21.

*Local Barometric curves during the progress of the two Cuba Gales in October 1844.*

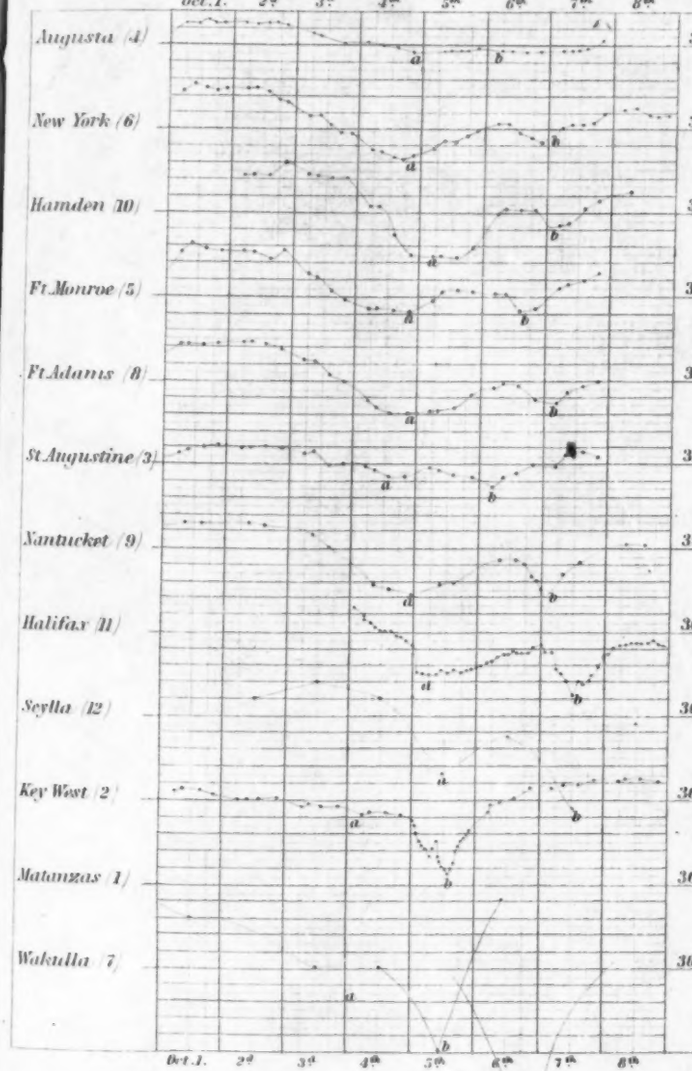



Fig.22.

*The same Barometric curves adjusted to one point of progress*

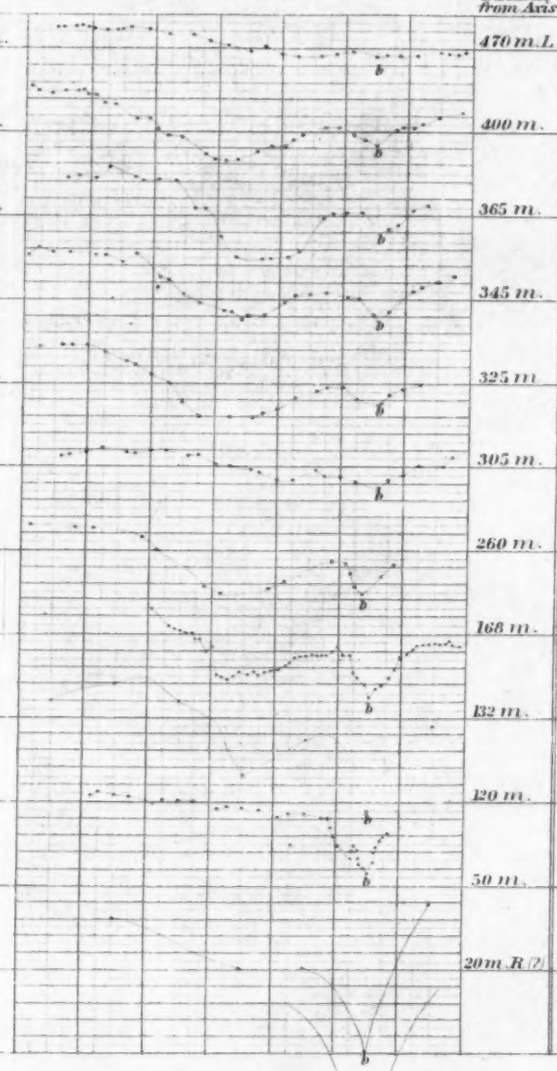
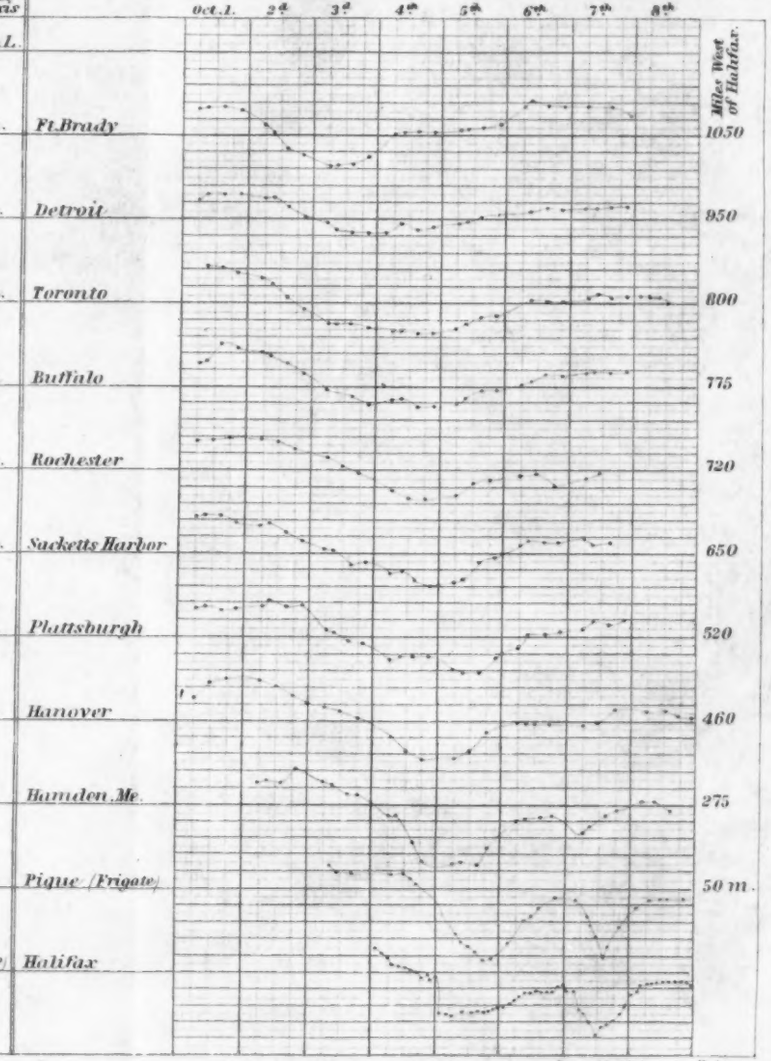



Fig.23.

*Local Curves in the Route of the Lake Storm in its approach to the Routes of the Cuba Gales.*




Engraved by J.H.Attwood, New York.

*Vertical scale one half. Each principal line indicates 30 inches; the interval to the next line, one inch. — a marks the minimum of the first gale — b the minimum of the Hurricane or second gale.*

Wakulla.

at S. E. is noted on the 4th,—winds strong from S. W., N. E. and N. W. on the 5th,—and northwesterly on the 6th. In more southern portions of this storm the winds were southerly, and southwesterly, for the most part,—passing to the W. and N. W. The subsequent state of the storm in approaching the Atlantic, may be seen in the previous recitals, at stations where the effects of this and the first Cuba gale appear as partially blended, or as closely succeeding each other. Numerous observations which were made in New York and other states, at this period, are omitted for want of space; but these appear to afford no additional facts or views requiring our consideration.

In overland storms of this character, where but little force is found in the surface winds, attempts to map out the true vortical course of the storm-wind by means of the local observations will be but partially successful. This difficulty may be owing in part to the want of symmetrical uniformity in the revolving action, and to the diversities of the positions and elevations, over the face of a great continent or island, as well as to the intrusion of other winds, stratiformly, in the same geographical area. Thus the true horizon of the storm-wind may be but imperfectly noted, in the assemblage of observations, and different strata and fluctuations of the aërial currents be represented to our view as being in the same plane of movement. These and other causes of discrepancy and want of conformity in the winds, the enquirer may be wholly unable to classify or detect. Strongly characterized as was the Cuba hurricane, we have seen, clearly, the intrusion of other winds beneath the true horizon of the storm, in the New England states. Indeed, too much reliance may be placed upon mere observations of the surface winds, in meteorological inquiries. But the falling of the barometer in the storm, and the direction, strength, and order of succession of its principal winds, on one or both sides of the storm-path, will commonly afford sufficient evidence of its essentially revolving character.

Lake Gale or Hurricane of October 18th, 1844.—Two weeks after the occurrence of the Lake storm above noticed, a very violent and destructive gale passed over the basin of the great Lakes, on a course which also nearly corresponds to No. XI, on Chart I. Its effects were eminently destructive to the vessels on the Lakes, and also in the town of Buffalo, and during its further progress, it was severe also in Maine, Nova Scotia and the

estuary of the St. Lawrence. At New York, and, generally, in the interior of the continent, the anterior winds of this gale were felt but moderately, though, at Toronto, the barometer fell to 28·86; the violence of wind, at the surface, being chiefly in the posterior side of the storm, on the rising barometer, as is the case in most of our overland gales, and in many of those on the Atlantic. This common feature of the Lake storms greatly enhances the value of the barometer, in navigating these inland seas.

### *Relations of the Cuba Gales to the Northers of Honduras and Yucatan.*

Having previously shown that a portion of the great storms of the United States and the Atlantic ocean are identified with the Mexican Northers, several of which have been traced to the Atlantic,* it remains to notice a like identity of the Northers of Yucatan and Honduras with the storms which sweep over the island of Cuba and the Atlantic ocean. The common name of Northers has been applied to the gales which visit the northern coasts of Central America, as well as to those of Mexico, as far eastward as the Musquito coast and gulf and near to lon. 80°, over which region they are found frequently to occur, except in the summer months. The swell from these Northers is often injurious in ports of this coast which are sheltered from their immediate force.

From the Musquito coast to Cape Honduras, (lon. 83° to 86°,) when the wind gets "to S. E. and then veers to S. and S. W., a gale will surely succeed." These gales are very violent, and occur more frequently from W. S. W., west, and N. W., than from north.—Upon the Musquito shore, Honduras, and the eastern coast of Yucatan, the general winds are frequently interrupted in February and March by *norths.* In September, October, November, December, and January, the winds are from the northward or southward of west, [northwesterly or southwesterly,] with frequent gales from W. S. W., W., N. W., and north.—On the north-

* The events of the present year, (1846,) have served to bring to our notice the frequent occurrence of the Northers in the countries and on the coasts which border the Mexican sea, and their subsequent progress to the Atlantic as revolving gales, not only during the winter season but in the months of May, June, and July. Indeed, it would be an error to suppose that American storms or gales are limited, in their occurrence, to any one portion of the year. The great gale of the Atlantic coast, Sept. 8th—10th, since the foregoing was in type, was also a norther from the Gulf of Mexico, where it caused the loss of the steamer *New York*, and other vessels on the 6th and 7th.

ern and western coasts of Yucatan, the general winds are interrupted by hard Northers, in the season of them.*

That these northers of Central America move in a regular course of progression, like other storms, cannot well be doubted. In the case of the *Racer's* gale, we have seen that the course corresponds with the westerly progression of hurricanes which have visited the windward islands of the Antilles; while in the two Cuba storms, which have been considered, the northeasterly progression has been found commencing in the northwesterly portion of the Caribean sea. A like course with the latter, I find was pursued also by other hurricanes from the Caribean sea, which have crossed the central portion of Cuba.

A similar course, at least from the north side of Cuba, was taken by that destructive hurricane of the western Atlantic which passed the coast of the United States on the 11th of December, 1844. The hurricane which devastated the western part of Jamaica on the 3d of October, 1780, also pursued a northeasterly course from the Caribean sea, as I had occasion to notice in 1836, and has since been fully shown by Col. Reid, in his work;† and is the most eastward of the storm tracks known to belong to this particular group. Of these storms which have thus crossed the island of Cuba, not one has been traced from the eastern portions of the Caribean sea, and hence there is reason to conclude that they can only have belonged, locally, to the class of storms known under the appellation of Northers, on the western borders of that sea.

Relations of the Cuba Gale to Contiguous Winds and Aerial Currents.—These relations may be viewed, first, in reference to the rotation of the gale, and second, to its geographical progression.

I have already referred to the natural tendency to a left-wise rotation in the winds of the northern hemisphere, when moving on the earth's surface from the equator towards the poles. But it is evident, from the prevalence of violent storms in some regions and their absence from other localities in like latitudes, that this general tendency of rotation does not serve to explain the actual distribution or prevalence of these storms. I have found, however, on a careful examination of marine Journals, that this

* Derrotero de las Antillas.—American Coast Pilot, &c.

† Lond. Nautical Magazine, v, 203–204. This Journal, xxxi, 120.

tendency to rotation is commonly shown in some degree, in the successive phenomena and phases of the trade winds, in the region near St. Helena and in other tracts of ocean which are exempt from severe storms. In some other regions, as in the western portions of an oceanic basin in the tropical latitudes, the Indian ocean near Mauritius, and in the south Pacific from the Society to the Navigator's Islands, this tendency to a vorticular rotation appears to be directly promoted by local or specific causes, the most efficient of which are found in the actual courses of the several local winds or aërial currents, either in the same plane of the horizon, or at different elevations. Thus, Mr. Thom maintains that the hurricanes of the Indian Ocean are due to the opposite or tangential action of the N. W. and S. E. monsoons on each other in that sea; and I apprehend that the earliest activity and violence of the intertropical hurricanes may often be rightly explained in this manner.*

This, however, cannot always explain the uniformity of the direction of rotation, nor the continued activity of the storms in their progress to other regions and in higher latitudes, where their greatest violence is sometimes developed.† Nor is the extraneous and tangential force of contiguous winds or currents at all necessary to the continued activity of the storm, when once the fall of the barometer and the involute vortical movement has been produced; for the pressure of the external atmosphere, around the basin of the storm, constantly aids or impels the involute movement at the earth's surface, and may be sufficient to maintain the existing vortical action, as may be seen in the case of a common vortex or whirlwind.

We have seen that the two Cuba storms, as well as the Mexican Northers, have appeared to come from the contiguous border of the Pacific ocean. Now, are there any peculiarities in the winds and aerial currents of those regions which may serve to induce or support a leftwise rotation in extensive portions of the lower atmosphere, while moving on or near the earth's surface? I apprehend there are such peculiarities, which have an extensive, constant and powerful influence.

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* In such cases I suppose that extensive portions of these different or opposite winds may coalesce in a vast gyration; instead of pursuing their usually independent courses, stratiformly, without interference with each other.

† As in the case of the extremely violent hurricane near lat. 50° in the eastern Atlantic, December 12th, 1844.

First, we find on the eastern portion of the Pacific from Upper California to near the Bay of Panama, an almost constant prevalence of northwesterly and westerly winds at the earth's surface. Next we have an equally constant wind from the southern and southwestern quarter which, having swept the western coast of South America, *extends across the equator to the vicinity of Panama*, thus meeting, and commonly oversliding the above mentioned westerly winds and tending to a deflection or rotation of the same from right to left, ↺. As this influence may thus become extended to the Caribean or Honduras sea, we have next the upper or S. E. trade of this sea, which is here frequently a surface wind, and must tend to aid and quicken the gyrative movement, ↺ ascribed to the two previous winds; and lastly, we have the N. E. or lower trade from the tropic, which coinciding with the northern front of the gyration, ↺, serves still further to promote the revolving movement which may thus result from the partial coalescence of these great winds of Central America and the contiguous seas.

Thus, while a great storm is in part on the Pacific ocean, its N. E. wind may be felt in great force on that side of the continent, through the great gorges or depressions near the bays of Papagayo or Tehuantepec, as noticed by Humboldt, Capt. Basil Hall and others, the elevations which there separate the two seas being but inconsiderable; and when the gyration is once perfected, the whole mass will gradually assume the movement of the predominant current, which is generally the higher one, and will move off with it integrally; as we see in the cases of the vortices which are successively formed in particular portions of a stream, where subject to disturbing influences. It is true that different winds which are found moving direct or obliquely towards each other in the aërial ocean, are never found to *meet*, in the opposing or antagonistic sense, any more than currents of the aqueous ocean; but they either stratify one upon the other when arriving on the same field, or else blend in a partial or common gyration and a united progression of their masses.

There seems, then, to be sufficient cause why the prevailing winds of southern Mexico and Central America should assume an aggregated and sinistrorsal rotation, such as is successively exhibited in the Northers and Atlantic storms;—why the Norther originated in the dry wind of the Pacific coast, should on first

reaching the S. W. border of the Gulf of Mexico at Vera Cruz, be found to afford little or no rain;—and why these North American storms should be distinguished for their almost regular *periodicity* of occurrence.*

Progress of Storms due to Prevailing Currents.—That the progression of these and other storms is caused by the predominating current in which they are imbedded, appears nearly a self-evident proposition; and there is much evidence of the prevalence of aërial currents which correspond to the courses pursued by the several storms.

At the windward islands of the Antilles, we have seen that the course of the *lowest* trade winds is often from E. to S. E.; although, from thence to the northern border of the trades, it comes, most commonly, from the N. E. quarter. Mr. Lawson has shown us that at Barbadoes, during a part of the year, the predominating course of the wind, both at the surface and in the region of clouds, is from east to southeast, and this is also the prevailing course of the higher portion of these winds in other months.† His observations, which are confirmed by others, may be deemed to show the actual course which is there pursued by the great body of the trade wind, and thus may fully account for the west-northwesterly course which is commonly pursued by the hurricanes of the Antilles, while passing to the extra-tropical latitudes. In the United States and north of the tropic in the Atlantic, the predominating currents come from the southwest quarter, which also corresponds to the courses here pursued by the great storms.—I have now to maintain that this prevailing southwest current exists far back in the intertropical latitudes, where it is derived, not from the trade wind of the Atlantic, north of the equator, but, to a large extent, from the prevailing winds of the Pacific ocean.

In the lower latitudes a general current from the southwest quarter has been noticed, as seen in the common course of the higher clouds, which pertain to the lower half of the atmosphere;

* The interval between the great Cuba gale and the next stormy weather was the same at both Campeche and New York. I have long since referred to the tendency or approximation to weekly periods which is shown in the occurrence of our storms; a fact which is very generally noticed when they occur on Sundays. At some seasons they are often bi-weekly. From the nature of the case, this periodicity is not absolute, but variable.

† *Ante*, vol. i, 2d Ser., p. 13, foot note.

while immediately below this current the upper portion of the trade wind is found to be from the southeast, as above noticed, and no longer moves towards the equator, but becomes also in due course of its progression to the higher latitudes, a southwesterly wind. This higher and main current from the southwest, coincides with the observed course of the two Cuba storms in the lower latitudes; and in its further progress and periodical variations it also accords with the general course of the storms which have been traced in the temperate latitudes.

That this predominant current is mainly or largely due to the prevailing winds of the Pacific Ocean, I cannot doubt. The great extent of northwesterly and westerly winds found on the eastern border of the Pacific, *in the trade wind latitudes*, has been noticed above, and a portion of this current appears to find its way to the southern parts of the Caribean sea as a surface wind, at certain seasons. Without inquiring whether the higher portions of this current of the north Pacific may not unite with the westerly winds of the Atlantic basin, it may suffice to state, that on the southern coast of Central America it is not found within six or eight degrees of the equator. On the contrary, we here meet with the vast stream of southwesterly winds, which have crossed the equator from the southern hemisphere, where they constantly prevail, as the southerly winds, on the coasts of Chili and Peru. That the lowest and most westward portions of this current are deflected in the southern hemisphere and merged with the southeast trade wind, I do not doubt; but the main current still pursues its course, which is necessarily more towards the northeast on crossing the equator, and in its further progress, as above stated, it is found superimposed on the westerly and other inferior winds of Central America and southern Mexico, and constitutes the main southwest current which is so often recognized in the lower latitudes.

There are two other extensive winds of the Pacific, of a character somewhat anomalous, which in their ultimate tendencies may serve to promote and strengthen this aerial movement to the north Atlantic basin; first, the great westerly monsoon, south of the equator, which, even as a surface wind, is found to cross the greater part of the Pacific, from the Indian Seas, in the principal season of the Northers; and, second, the equatorial belt of westerly winds, which is so remarkable a feature in the aërology of that great ocean.

The course of the great aërial stream into the Atlantic basin, after crossing the equator from the southern hemisphere, is seen from other evidence than the reported courses of the clouds, and occasional surface winds. We learn from Humboldt, that in the great eruption of Jorullo, a volcano of southern Mexico, which is 2100 feet above the sea in lat. 18° 45′, lon. 101° 30′, the roofs of the houses in Queretaro, more than 150 miles N., 37° E. from the volcano, were covered with the volcanic dust. In January, 1835, an eruption took place in the volcano of Cosiguina, on the Pacific coast of Central America, in lat. 13° N., and having an elevation of 3800 feet, the ashes from which fell on the island of Jamiaca, distant 730 miles N. 60° E. from the volcano. The elevated currents by which volcanic ashes are thus transported, are seldom or never of a transient or fortuitous character, and these results therefore afford us one of the best indications of their general course. Thus the progress of the higher portion of the trade wind was marked by the eruption of Tuxtla, lat. 18° 30′, lon. 95°, which covered the houses in Vera Cruz with ashes, at the distance of 80 miles, N. 55° W. and also at Peroté, 160 miles N. 60° W. The ashes from the volcano at St. Vincent, which fell at Barbadoes and east of that island in 1812, mark the course of a current from the westward, which appears there at times, in the region of clouds, and may perhaps be connected with the permanent winds on the Pacific coast of Mexico. Few facts in meteorology are more worthy of our attention than the stratiform character and the vast horizontal extension of the aerial currents, in different portions of the globe.*

Over the United States and the temperate latitudes of the Atlantic the course of this great southwest current is strongly marked both by the movements of the clouds and the general course of the surface winds, notwithstanding the degree of obscurity which is induced by the generally revolving character of the lower winds; for even the northeasterly and northwesterly winds are found comprised in a general movement of the lower atmosphere towards the northeast.† Thus, we find the great Cuba

* For the positions of the volcanoes of Cosiguina and Jorullo and course of the drift, see Charts I and IV.

† For results of seven years' observations on the courses of the clouds and the lower winds, at New York, see this Journal, i Ser., xxxiv, 373; and xxxviii, 323, 324.

hurricane moving in this direction, with a progress of 500 to 1000 miles per day, overlaid and accompanied by a regular southwest current; and yet, if we should attempt to resolve the aggregate course and progression of this storm solely by a general mean of its observed winds, at the earth's surface, we might be led to very erroneous conclusions. For these rotary winds, instead of showing the true progression of the storm, might appear nearly to balance each other. Moreover, the winds of this storm, when considered locally, are found to exhibit nearly the same phases or succession of changes which are common to the temperate latitudes of the north Atlantic basin; which serves to show that our successively observed winds are commonly of a rotary character, and that the common method of estimating the mean resultant courses or progression of the surface winds is necessarily defective and cannot show the true progression of the lower atmosphere.

Some writers have described our northerly winds as sweeping from Canada to the Gulf of Mexico and Cuba, and thus reducing the temperature of the latter regions. But it is evident that these persons have mistaken the cold winds which are found on the western side of our revolving storms, as being a direct current from the higher to the lower latitudes. I cannot find that the above geographical course has ever been pursued by the winds of this continent. On the contrary, in times of the greatest depression of the thermometer, in numerous instances, the cold period has been found to have first taken effect in or near the tropical latitudes and Gulf of Mexico; and has thence been propagated towards the eastern portions of the United States, in a manner corresponding to the observed progression of the storms.

The only proper current of surface winds found coursing towards the equator, in the temperate latitudes of North America, exists on the western side of the continent. But a high current from the northwest, which may have crossed the Rocky Mountains in its course, appears at successive and alternate periods, of considerable duration, in the higher region of clouds. Its direction nearly coincides with the closing winds of our revolving storms, and in the winter season, in some cases, it probably subsides to the surface and immediately follows these storms, for two or three days, and sometimes longer. This will accord with views which have been expressed by the late President Dwight

and other writers. But I have in no case found the integral progression of a great storm to be in accordance with the specific direction of this wind.

To my own apprehension, it is the constant course of the lower winds towards the equator, on the western shores of America, below the latitude of 40°, that best explains the aridity of those regions. And it is to a *counter* course of progression, in the lower atmosphere, that the United States, China, and western Europe are mainly indebted for their rains and fertility. To these general and remote causes may also be ascribed the varied electrical and hygrometric phenomena of these different regions.

In closing these imperfect remarks and statements on the American tempests, I tender my thanks to all who have aided me in the inquiry. To Col. Reid, Governor of Bermuda, and through him to Vice Admiral Sir Charles Adam, and other officers of the British Navy, and to the officers and agents of the R. M. steamships, I am indebted for valuable logs of various vessels. Surgeon General Lawson, under the favor of the War Department, has kindly furnished me with the meteorological reports from our military stations, and by the aid of Lieut. M. F. Maury and the favor of the Navy Department I have obtained the logs of our national vessels. Prof. J. R. Beck, secretary of the Board of Regents, has given me free access to detailed reports from the several academies in the state of New York, and various professors and other gentlemen have furnished me with copies of their private journals. I am indebted, also, to many merchants, shipmasters, and others, for important aid, and can only hope that the results attained may prove useful to those who may be engaged in commercial and other pursuits.

Practical Deductions.—It was my purpose to add some further practical exposition of the law of rotation and progression in storms, which might aid the mariner in avoiding their destructive violence, and render the rotary winds and gales more subservient to navigation; but my proposed limits have already been exceeded. It is necessary, however, that the character and general extent of the rotation, and the usual courses of progression, be once clearly understood. Perhaps no one case can better illustrate these conditions than the Cuba hurricane, viewed in its

successive positions and local changes of wind, as shown in Charts IV to X, and compared, also, with the varying courses of progression which are shown in Chart I. Let the mariner suppose himself in any position which may fall under the approaching gale as there delineated, and he may perceive the successive changes of wind which must necessarily take place, as the gale passes onward. This gale, in its various local phases, may be taken as illustrating pretty fairly, nearly all the great storms in the northern temperate latitudes, as well as the successive local changes of a large portion of the common winds of these latitudes.

The chief difficulty, in some latitudes, may be in determining the actual course of the gale's progression; for the choice of any course for avoiding the heart of the gale must depend partly on this knowledge. But the local position and latitude of the ship, together with the attending appearances of the storm, will commonly afford sufficient indications.

But a course for avoiding the heart of the storm is not all that is to be considered; for this may be controlled by imperious circumstances or considerations, and little choice be allowed. Other things being equal, it is important, in the commencement of a gale, to take such a course as will be favorable to the ultimate prosecution of the voyage, and will enable the ship to encounter with most safety that portion of the gale which may be chosen, or found unavoidable. This may involve the questions of *scudding* and of *lying to*, which must partly depend on the character and lading of the vessel; and also the *tack* to be preferred, in the latter alternative. The early direction of the storm-wind and the course taken by the ship, will usually decide the further changes of the gale, and it will be proper to lay on that tack in which the ship's head will come up to the sea, as the wind veers or changes,—not that on which she will be headed off by the wind into the trough of the sea, and perhaps taken aback in the heart of the gale. A glance at the storm figures on the Charts will commonly show which tack should be chosen, in different parts of the storm, by vessels bound in different directions. The chief difficulty in deciding is when the ship happens to be on or near the axis of the gale; in which case the discretion of the mariner must rule; but it is desirable first to get away from this line as far as possible. The *degree* of caution and forethought which it may be proper to exercise, may best be deter-

mined by the indications of the barometer, not neglecting other appearances.

Thus when vessels are bound westward, in the temperate latitudes, and have southeasterly winds with a falling barometer, they should steer to the northward and westward, instead of keeping their direct course; and when the wind has veered to the northeast quarter they may resume their true course, with a fair wind which will veer northward; but if finally compelled to heave to with the wind northeasterly or northerly, they should then take the *port tack*, so as to come up to the wind, in its further changes. This curved course will be found to favor a speedy passage, in most cases, as it gives a fair wind of longer continuance, by placing the ship in the left side of the storm path, and in a position which renders the subsequent northwesterly wind more available. But in case of a gale's hauling *southward* and westward, the ship, when headed off from her course, should be hove to on the *starboard* tack, being in the right hand side of the storm path. The ship will then come up to the sea, as the wind veers by the west towards the northwest.

It will at once be seen that in revolving winds a direct course is not always most conducive to a quick passage, but such variable course should be preferred as will render available the succeeding changes of the wind; which changes, whether by *south* or *north*, sometimes depend on the course of the vessel.*

The foregoing statements and suggestions are equally applicable in the southern hemisphere, with only this difference; viz., that in the actual courses of the winds and storms, *south* is there always substituted for north; east and west remaining the same. Hence, the practice must be varied accordingly.

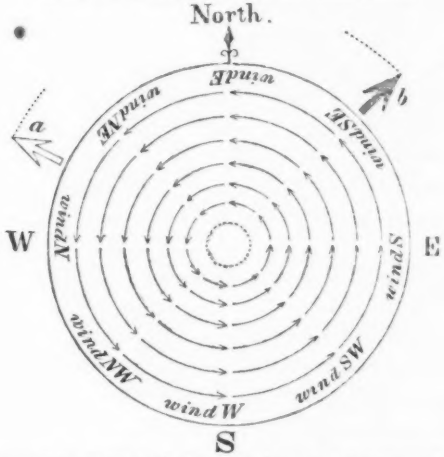
These practical deductions accord with the statements and diagrams which I have published in 1831 and subsequent years. Storm figures of this kind, better elaborated, have also been given by Col. Reid, in his work, accompanied with remarks on lying to, and by him and Mr. Piddington have been placed on cards, and on plates of horn or glass, in order that a mariner may determine the place of a vessel in a storm, by placing the figure on the face of his chart, in such manner as to coincide, on the outer

* See, also, Col. Reid's valuable Note on Progressive Revolving Winds and the Advantages of Sailing on Curved Courses; Jameson's Ed. New Phil. Journal for July, 1846. Also, Remarks on Lying to, in the Messrs. Blunt's forthcoming edition of the Young Seaman's Sheet Anchor.

circle, with the observed direction of the storm-wind, at the first freshening or commencement of the gale. In this manner the geographical position and coming changes of the storm may be apprehended by those who may not fully comprehend the law of the wind's rotation.*

These storm figures and their uses, may be exemplified in the annexed diagrams.†

Fig. 6.—Storm Figure for Northern Hemisphere.




*a*, General Course of the Storm in the low latitudes; changing successively to *b*, which is the general course in the Temperate latitudes.

Directions.—First, mark the position of the ship on the Chart, at the beginning of a gale, and then place this figure to the southward of such position, with the needle pointing to the North, and in such location on the Chart that one of the wind arrows in the outer circle will conform to the actual direction of the wind. This will show nearly the true position of the storm at that time. Then move forward the figure in the direction in which gales commonly advance in that latitude and locality, but without turning the figure. The arrows which are thus brought in succession over the ship's place, will show the changes of wind which may be expected, in the further progress of the gale; and also, into what portion of the storm the vessel will be likely to fall, in her then position, and what changes of the ship's course will be likely to favor her safety and the further prosecution of the voyage.

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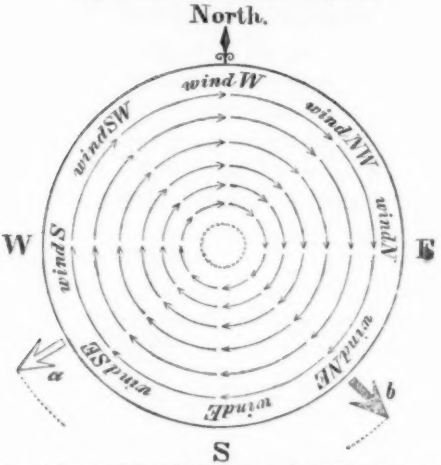
* See Col. Reid's work, first edition, pp. 5—7 and 424—427. Weale, London, 1838. Also, Horn Book of Storms, for the Indian and China Seas, by Henry Piddington: Ostell & Lepage, Calcutta; W. H. Allen, London, 1845. I have lately received from Mr. Piddington his Thirteenth Memoir, which relates to the hurricane of the *Charles Heddle*, before mentioned, and is well worthy of the attention of both navigators and meteorologists.

† See, also, Bowditch's Navigator, edition of 1839, pp. 441, 442; edition of 1845, pp. 440, 441.

Fig. 7.—For the Southern Hemisphere.




*a*, General Course of the storm in low latitudes, south of the Equator; changing, on its approach to the tropic, to *b*, which is the general course in the southern Temperate latitudes.

Directions.—Place the figure or storm card as before, with the needle pointing to the north, and follow out the directions as before given. The size of the storm figure, for use, may be drawn to the common proportions of a storm on the Chart.

In the Atlantic ports of the United States, the approach of a gale, when the storm is yet on the Gulf of Mexico, or in the southern or western states, may be made known by means of the electric telegraph; which, probably, will soon extend from Maine to the Mississippi. This will enable the merchant to avoid exposing his vessel to a furious gale soon after leaving her port. By awaiting the arrival of a storm and promptly putting to sea with its closing winds, a good offing and rapid progress will be secured by the voyager.

However useful the knowledge of storms may prove, no one will expect the tempest to be disarmed of its power. Nor can disasters in navigation be in all cases avoided. But, contemplating this subject in its relations to the thousands of lives and the millions of property which are lost by shipwreck, almost annually, we cannot doubt that much of this loss might be prevented, by the exercise of timely and intelligent precaution. Indeed, the practical value of accurate knowledge and investigation, in all branches of science, is generally admitted; and in so important a matter as that of the rotation and progression of storms, it will not be estimated too highly.

New York, Sept. 2d, 1846.

## Art. XXX.—*On the Volcanoes of the Moon;* by James D. Dana.

(Read before the Assoc. of Amer. Geologists and Naturalists, Sept., 1846.)

The surface of the moon affords a most interesting subject for the study of the geologist. Though at a distance of many thousand miles, the telescope exhibits to us its structure with wonderful distinctness; and already, as a learned astronomer has observed, we are better acquainted with the actual heights of its mountains, than with those of our own planet.* Having an atmosphere of extreme rarity† (if any) and never obscured by clouds, its features are wholly open to view, and the eye aided with glasses, may wander over its rugged crags, survey its craters, its Alps and its Apennines, from their bases to their summits. Neither are there any sedimentary deposits, soil or vegetation,—for there can be none without water,—and the igneous surface therefore is still its own naked self, exhibiting the results of ig-

* M. Arago, Annuaire des Longitudes, pour l'an 1842, 2d ed., Paris, 1842.—P. 526, in an article on the Lunar Volcanoes, Arago says:—"Il est remarquable que grace au zèle et à l'exactitude d'Hevelius on ait connu la hauteur des montagnes de la Lune beaucoup plus tôt que la hauteur des montagnes de la Terre."

† The evidence in favor of the existence of an atmosphere and of water in the moon, hitherto obtained, has not been deemed satisfactory. Herschel, at an eclipse, Sept. 5, 1793, observed the sharp horn of the limb of the moon, and says that it seemed perfectly regular; and that a deviation of a single second by the refraction of the solar light in the moon's atmosphere would not have escaped him. *Phil. Trans.*, 1794, p. 39.—As stated in Beer and Mädler, (p. 133,) Schröter calculated the density of the supposed atmosphere to be one twenty-eighth the density of our own atmosphere; and Melanderhjelm demonstrated that the moon's atmosphere, judging from that of the earth, should have one thirty-sixth the density of our own atmosphere. But the above mentioned authors say that we have yet to prove that the moon has any atmosphere, adding that it must be very much more rare than the rarest gas on earth. They observe also that supposing our atmosphere to extend through space, its density half way to the moon, according to the Mariottian law of decrease, would be expressed by the fraction $\frac{1}{100000\ldots}$, the denominator extending to ten thousand zeros. The singular observation occasionally made, that during the passage of the moon over a star, the star appears visible in front of the edge of the moon, before disappearing, may possibly indicate an extremely low atmosphere or surface vapors: but it has been attributed with much appearance of reason (Rep. Brit. Assoc., 1845, p. 5) to diffraction.

The absence of any bodies of water on the moon is placed beyond doubt, both by actual telescopic examination and by inference from the absence of clouds. There are no streams, lakes or seas. An eminent astronomer has remarked that the heat of the surface exposed to the sun would occasion a transfer of any water the moon might contain to its dark side, and that there may be frosts in this part, and perhaps running water near the margin of the illumined portion. But in such a case, would not clouds appear about the margin at times in telescopic views?

neous action in their simple grandeur, unaltered and uncomplicated by any attending operations. We may hope therefore to find some profit in contemplating for a few moments this land of the skies: and although we may not look for very speedy "annexation," we may possibly gather some facts and ideas which the decree of Truth will annex to the domain of Science.

The moon, as we all know, has been minutely studied in a physical point of view, and already some important geological conclusions have been drawn from the facts it presents. The altitudes of its mountains were first estimated by Galileo,* and afterwards were mathematically calculated by Hevelius† and Riccioli. Sir Wm. Herschel continued the investigations, and reported the probable activity of three of its volcanic mountains.‡ Mayer, Huth, Harding, and Schröter,§ and more lately Gruithuisen and W. G. Lohrmann,‖ are other prominent names among those who have added largely to our knowledge of the moon's surface. More recently still, MM. Beer and Mädler have pursued this science of Selenography with wonderful perseverance and labor, and have given corrected results of all previous calculations, with magnificent maps of the moon's topography.¶ 1095 heights were carefully measured by them, and their features, to a great degree of accuracy, ascertained. These maps have afforded M. Elie de Beaumont some deductions alledged as supporting certain geological theories. James Nasmyth, Esq., in the Transactions of the Royal Astronomical Society for the present

* In the article referred to in the Annuaire des Longitudes, (p. 522,) Arago states that Clearchus, on the authority of Plutarch, described the moon as smooth and lustrous like a mirror. Democritus attributed the spots to inequalities of surface. Galileo first observed the lunar mountains with his telescope in 1610, and estimated their height at one twentieth of the diameter, giving 8800 metres for their altitude, which but little exceeds their actual height.

† J. Hevelius, Selenographia; fol., Gedani, 1647.

‡ *Phil. Trans. for* 1780, p. 507, Astronomical Observations relating to the Moon: —*for* 1787, p. 229, An Account of Three Volcanoes in the Moon:—*for* 1794, p. 39, Account of some particulars observed during the late Eclipse (in 1793) of the Sun.

§ J. H. Schröter, Selenotopographische Fragmente zur genauern Kenntniss der Mondfläche ihrer erlittenen Veränderungen und Atmosphäre; 2 vols, 4to, Göttingen, 1791 and 1802.—Gruithuisen, in Bode's *Astron. Jahrb.*, 1825.

‖ Topographie der sichtbaren Mondoberfläche, von W. G. Lohrmann; 4to, Dresden und Leipzig, 1824.

¶ Allgemeine vergleichende Selenographie; mit besonderer Beziehung auf die von den Verfassern herausgegebene Mappa selenographica, von W. Beer und Dr. J. G Madler; Berlin, 1837

year, has published important observations on the features of the moon's mountains, and traced out their volcanic character.* A very valuable memoir on the same topics has been presented within the current year to the Institute at Paris, by M. Rozet, in which the moon is shown to have been a globe in complete fusion, which has slowly cooled; and its peculiarities are dwelt upon as an exhibition, in many respects, of the former state of our own planet.†

In all the geological observations which have been hitherto made with regard to the moon, one important feature remains unsatisfactorily explained. I refer to the vast magnitude of its craters. It is not surprising that in view of their stupendous size, many should have been incredulous as to their crater character, and preferred to designate them by some non-committal term, as circular ridges, or ring-mountains; nor that geologists in general have hardly ventured to acknowledge their belief in these lunar wonders. Imagine if possible, in place of an ordinary crater, circular areas 50 to 150 miles in diameter, and 10,000 to 20,000 feet in depth. Such are many of the lunar craters; and they are crowded in great numbers over the larger part of its surface, varying from even a more capacious magnitude, down to those that measure but a few miles in breadth. It is not astonishing that there should be found much difficulty in reconciling their features with those of Vesuvius and Etna, hitherto received too generally as the types of volcanoes and volcanic action. The crater of Kilauea in the Hawaiian Islands is of a wholly different character, and I propose to present some illustrations which it affords, appealing to such general facts regarding it as are already well known. If I mistake not, it will be found to give a full interpretation of whatever has been considered mysterious in these lunar ring-mountains. After these illustrations, we may return again to earth, and apply the knowledge which we have derived abroad, in exemplifying the former geological history of our own planet.

We may first consider the general features of the moon's surface.

About two-thirds of the lunar hemisphere in view, comprising almost the whole of the southern half and the northeast quarter,

* *Memoirs of the Royal Astronomical Society*, vol. xv, 1846: On the Telescopic Appearance of the Moon, by James Nasmyth, Esq., p. 147.

† Sur la Sélénologie, by M. Rozet, *Comptes Rendus*, 1846, xxii, 479.

are covered thickly with volcanic mountains. Over a large part of the northwest quarter, there is only here and there an elevation, and this comparative nudity extends a considerable distance southward across the equator.

The features of the surface may be distinguished as of five kinds, viz:—

1. The ring-mountains, which are broad truncated cones with immense circular craters. (See the following figures from Beer and Mädler.)
2. Conical mountains, nearly like ordinary volcanoes.
3. Linear or irregular ridges.
4. Large depressed areas, usually termed seas, but not supposed to contain water.
5. Broad pale streaks, of great length.
6. Narrow lines, supposed to be fissures.

Out of the 1095 heights measured by Beer and Mädler, *six* are above 20,000 feet in altitude, and *twenty-two* exceed 15,750 feet.

The broad truncated cones with large circular craters, are its most common elevations, and are among the loftiest. The pits, as we have remarked, are of all dimensions to 150 miles, and of various depths to near 25,000 feet. The crater *Baily* is 149½ statute miles in diameter; *Clavius* is 143⅓ miles; *Schickard* is 128 miles. 20 to 60 miles is the more common breadth. The depth of *Newton* is 23,833 English feet; of *Casatus* 22,822; of *Calippus* 22,209; of *Tycho* 20,181 feet.* The height above the sur-

* We have stated that Galileo (note to page 336) made the altitude of the higher of the moon's mountains 8800 metres. Hevelius reduced their height to 5200 metres. Riccioli, as M. Arago states, increased Galileo's estimate, and his observations, as calculated by M. Keill, gave for the mountain St. Catherine more than 14,000 metres. Herschel in 1780, (Phil. Trans. for 1780, p. 507; also for 1794, p. 40,) reduced again the heights, concluding from his observations that the loftiest did not exceed *a mile and a half*. The latest investigations have restored them nearly to Galileo's first estimate.

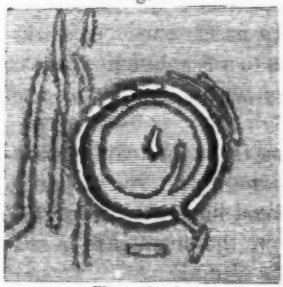
We state, for the information of some who have not paid attention to the subject, that these heights are determined, either from the shadows of the peaks on the central plain of a crater or the exterior surface, or by noting the position of a summit when it first becomes illuminated, and calculating therefrom; the higher the peak, the longer will be the shadow, and also, the sooner its top will be tipped with light. Should it hereafter be established that the moon has an atmosphere, it must be too slight to affect appreciably the altitudes determined: with regard to the breadth of the craters, there can be no more doubt, than with respect to the diameter of the moon itself.

There are many who receive with scepticism the facts we have stated, or even deny where they know nothing. It is taking a high ground, to dispute with all

face exterior to the cone, is said by Beer and Mädler to be often but one half or one third the height above the bottom of the crater; the outer slopes are generally steep, so that the margin appears like a raised rim around the pit.

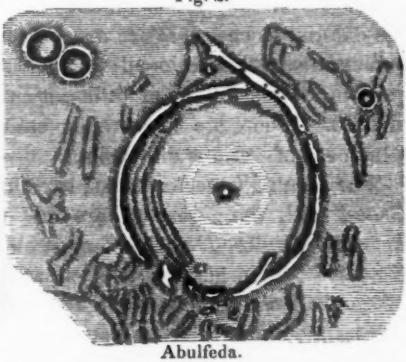
Mr. Nasmyth figures one which is filled to its summit, and is tipped with a plain 40 miles in diameter;* looking, he says, as if "brim full of molten lava," having cooled, probably, when thus filled.

Fig. 1.



Timocharis.

Fig. 2.

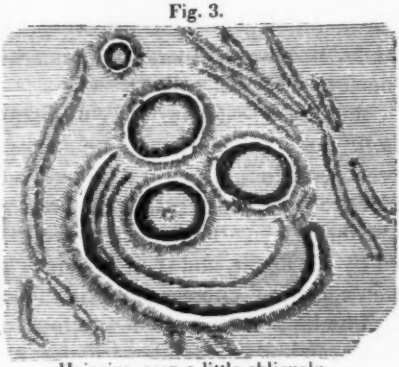


Abulfeda.

The largest craters are not contained in the highest mountains: on the contrary, they are of less altitude than those of medium size, and to a certain extent the height varies inversely with the diameter.

The pits are generally circular, and sometimes almost artificially regular. There are others which consist of two or more coalesced cir-

Fig. 3.



Heinsius, seen a little obliquely.

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the astronomers since Galileo, and one to which ignorance alone would presume. The best antidote we can propose to such presumption, is to take the first opportunity which offers, to look through a good telescope at the moon's surface, and examine its features for themselves. We predict that they will soon become conscious of a growing willingness to be humble learners of such men as Herschel and others who have made the moon their study.

* Mem. of the Roy. Astronom. Soc., xv, 152.

cular pits. In still others, especially the largest, the enclosing walls are broken into a series of ridges, sometimes with large openings like the break of an eruption: yet even then the irregular forms may generally be referred either to a single circle, to a combination of circles, or to the formation of successive ridges one within another. The bottom of the pits though generally flat or nearly so, not unfrequently contains small cones, or ridge-like elevations; we call them small, though some are 5000 feet in height, for they are mere dots in the immense basin. Over the exterior slopes there are many lateral cones of the same *small* dimensions, and occasionally one as large as Etna may be distinguished, besides others of different sizes to a few hundred feet in breadth. There are also circular craters within the larger pits, which are of various dimensions.

The pointed cones or peaks, excepting those immediately connected with the pit-craters, are few in number. According to Beer and Mädler, *Dörfel*, the most elevated lunar peak measured, is 24,945 feet in height; it is situated in the lunar Appenines: *Huygens*, another peak, is 18,209 feet in altitude.

The mountain ridges are peculiar in being generally elongated elevations, or clusters of such elevations, without valleys intersecting their declivities, and thus very unlike the chains of our globe. As M. Rozet and others have remarked, there is no water on the moon to wear out valleys.

Many of the depressions called seas, of which the *Mare Serenitatis*, and *Mare Crisium*, are examples, vary in breadth to five or six hundred miles, and notwithstanding their size, they are identical in character with the great pit-craters, their extent and less depth being their only characteristics. This view is suggested by M. Rozet, and their features clearly sustain it. They contain cones and circular areas like the better defined pits.*

The light streaks alluded to form radiating lines around large cones, and especially about *Euler*, *Kepler*, *Copernicus*, *and Aristarchus*. They are from one to five hundred miles in length, and cross ridges and depressions, without interruption. They coalesce about the summit of *Kepler*, so that the whole surface appears nebulous.

* The "seas," according to M. Rozet, have escarpments of 45 degrees, some of which are 400 metres in height. In the interior there are annular cavities, perfect rings in shape, the diameter of which attains sometimes to 100,000 metres.

The various pit craters differ in shade of color, or rather in the degree of light they reflect; and ten different degrees are distinguished in the work of Beer and Mädler. 1 to 3, he says, may be described as gray, 4 to 5 light gray, 6 to 7 white, 8 to 10 shining white. The so-called seas, though but slightly depressed, are sometimes very much lighter than the surrounding surface. In some instances, as these authors state, two pits, side by side, alike in size and features, so differ in brilliancy that one is wholly obscured in the full moon, while the other still shines: the two are seen together again as soon as their shadows reappear. The brightest craters are *Aristarchus*, *Werner* and *Proclus*. *Aristarchus* is 7629 feet in depth. It has a point of greatest brilliancy, besides two or three separate circular spots remarkably light. *Werner* has a single brilliant point. *Proclus* has brilliant walls, yet is dark at bottom.

Sir Wm. Herschel published the first account of existing volcanic action in the moon. In a notice of three lunar volcanoes,* he says that two of them, on April 19, 1787, were either nearly extinct or about to break out, while the third was in actual eruption. April 20, he observed that the active one burned with greater violence; and he estimated that the fiery area was above three miles in diameter. All the adjacent parts of the crater seemed to be illuminated by the eruption.† The other two volcanoes, he says, resembled large pretty faint nebulæ, that are gradually much brighter at the middle, but no well defined luminous spot could be distinguished. Herschel alludes also to an eruption seen by him previously, in 1783.

Such are the general facts, which call for explanation, to wit: the existence of circular pit craters, 5 to 150 miles in diameter, and five to twenty-four thousand feet in depth;—the great number of these pit craters, and their peculiar features;—the depressions of a similar character of still larger area;—and the various degrees of il-

* Phil. Trans. for 1787, p. 229.

† It is supposed that this crater was that called *Aristarchus*, or the *Mons Porphyrites* of Hevelius. *Aristarchus* is described as apparently in action in 1821, by H. Kater, in the Philosophical Transactions for 1821, p. 130; also by Rev. M. Ward, at nearly the same time, in the Memoirs of the Royal Astronomical Society, i, 157; also the following year by Rev. Fearon Fallows, in the Philosophical Transactions for 1822, p. 237. Dr. Olbers observed *Aristarchus* at the same time with Kater in 1821, and attributed the light to the reflection of the earth's light by its smooth rocks.

lumination of the craters. Well may the Vesuvian vulcanist look with doubt upon such vast gulfs; for he finds in his well known volcano, nothing parallel in kind or degree. The little dark hole at the top of his mountain, has scarcely a single point of resemblance to the open walled areas of the moon.

But the case is different with Kilauea, to which we now direct our attention. We observe that the facts this crater presents are precisely the same in kind as those of the moon.

1. The crater is a large open pit, exceeding three miles in its longer diameter, and nearly a thousand feet deep.

2. It has clear bluff walls through a greater part of its circuit, with an inner ledge or plain at their base, raised 340 feet above the bottom.

3. The bottom is a plain of solid lavas, entirely open to day, which may be traversed with safety; over it there are pools of boiling lava in active ebullition, and one is more than a thousand feet in diameter. There are also cones at times from a few yards to two or three thousand feet in diameter, and varying greatly in angle of inclination. The largest of these cones have a circular pit or crater at summit.

Compare these characters severally with the lunar craters, and an identity will be perceived even to the ledge that surrounds the lower pit, and the various forms of the cones. A large number of the lunar craters have an inner circle either as a terrace or ridge. The ledge within *Timocharis* (figure 1) is very similar to that of Kilauea, and is continued around the whole pit unbroken as in the Hawaiian crater. The other figures illustrate the same feature in different conditions. Some of them too contain circular areas with the rim scarcely elevated, (figure 2,) and others raised into cones, (figure 3): and so, in Kilauea, there are at times boiling lakes in the bottom plain, and other pools constitute the summits of cones which they themselves have formed. To appreciate the comparison, it must be remembered that the Hawaiian pit-crater is upwards of three miles in length, and averages nearly half this in breadth; and that the largest boiling pool, though more than a thousand feet in diameter, is still a small spot in the extensive area. During times of greater activity, the whole pit is in every part lighted with the fiery lavas, overflowing at times from the numerous lakes, and jetted from the many cones.

The *circular* or slightly elliptical form of the moon's craters is also exemplified to perfection. For the lakes of Kilauea have this shape; and although the pit itself is oblong, owing to its situation on a fissure, other large though extinct pit craters of Mount Loa are quite as regularly circular in form. Some are twins; that is, are made up of two or three coalescing circles.

We have chosen Kilauea for these illustrations because it is now in action, and the features appealed to have been familiar to us, since the first publications of Admiral Byron, and Rev. Charles S. Stewart. I may add that the facts are finely illustrated in the Narrative of the Exploring Expedition by Capt. Wilkes,* and they will be farther detailed in the Expedition Geological Report on the Hawaiian Islands, now in course of preparation. The exact application of these facts, as far as regards general features, to the *summit* crater of Mt. Loa, will be found fully sustained by the plans and views accompanying the Narrative.

Whence all this close resemblance to the lunar craters, while other volcanoes are so different? It arises from the fact that the action at Kilauea is simply *boiling*, owing to the extreme fluidity of the lavas. The gases or vapors which produce this appearance of active ebullition, escape freely in small bubbles with little commotion, like the jets over boiling water; while at Vesuvius and other like cones they collect in immense bubbles before they accumulate force enough to make their way through; and consequently the lavas in the latter case are ejected with so much violence, that they rise to a height often of many thousand feet and fall around in cinders. This action builds up the pointed mountain, while the simple boiling of Kilauea makes no cinders and no cinder cones. Still, although the lavas of this crater are not thrown to a great height, they may make cones of any angle, even by overflowing alone; especially by small or partial overflowings, which melt together, cooling at the same time rapidly. They thus sometimes raise a steep rim around a pool. This point has been well presented by M. C. Prevost,† and in another place we shall mention many facts in illustration of it.

If the fluidity of lavas, then, is sufficient for this active ebullition, we may have boiling going on over an area of an indefi-

* See Narrative, Vol. iv, p. 125, and the map of part of Hawaii in Vol. vi.
† Bulletin de la Soc. Geol. de France, xi, 1839 à 1840, p. 183.

nite extent; for the size of a boiling lake can have no limits except such as may arise from a deficiency of heat. The size of the lunar craters is therefore no mystery. Neither is their circular form of difficult explanation; for a boiling pool necessarily, by its own action, extends itself circularly around its centre.* The combination of many circles, and the large sea-like areas are as readily understood.†

With so perfect a correspondence, and so satisfactory explanations by means of an appeal to facts, it is hardly necessary to enter a protest against the ordinary view that these craters are the result of cinder eruptions.‡ We remark only that such eruptions will never take place except from small vents, for the cold which gives the viscidity on which they depend, necessarily contracts the area. In a large pool the fluidity is such that the rising vapors pass off freely: the ejections over its surface, excepting those at the margin, will fall back again into the pool, as in boiling water and Kilauea, and could neither rise to the height nor make such curves as are represented by Mr. Nasmyth. Instead of a large open crater having greater projectile force in proportion to its size, it will actually have far less; and within certain limits the force may be inversely as the diameter, though dependent also on the size of the chimney above.

Any vents in the moon in which the fires had partially subsided, would have densely viscid lavas from partial cooling; and in these there would be loftier ejections like those of ordinary volcanoes, forming high conical peaks with narrow openings, if any, at summit.

The great depth of the lunar pits seems to require another element for its explanation, in addition to what has been presented. This is supplied by the fact of the less specific gravity of substances on the moon; for objects on its surface have but one-sixth the specific gravity they have on the earth: that is, iron would

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* Mr. Nasmyth suggests that the quietness of the lunar atmosphere may account for the regularity of the circles.

† M. Rozet observes, in his article referred to, that the moon's craters do not resemble those of our volcanoes: and he explains them by supposing that during the cooling of the moon's surface there were *whirlpools* or circular flowings, which carried the scoria from the centre to the circumference, and thus accumulated the enclosing ridges. We see no cause for the existence of whirlpools; nor for such a result from vortical movements.

‡ See the views and remarks of Mr. J. Nasmyth, *loc. cit.*

weigh but one-sixth what it does here. The lavas would therefore not only be specifically lighter, but would become more blown up with the vapors, or more spongy. On the same ground too, we understand why the moon's great craters should so generally terminate in a raised rim, while those of the earth, like Mount Loa, have very gently sloping sides and summit. This raised rim is fully illustrated about the Kilauea pools, as we have already stated: but in large overflowings, the earth's lavas, owing to their weight, flow far away by gravity, and this feature is therefore never exemplified on the earth on the same grand scale as in the moon.*

We may therefore say unhesitatingly, without fearing an impeachment of our sobriety, that the moon's volcanoes are in fact volcanoes, either extinct or active, although the craters would receive comfortably more than a score of Etnas. We also comprehend the important fact, that a cooling globe would become at first a scene of great boiling lakes from the hardening of some portions;—that on a farther diminution of heat, these lakes would partially cool, excepting points or areas of greatest heat, and thus a subdivision of them would result: or else, they would *gradually* contract their overflowings, and so, as gradually, contract the size of the vent, obliterating all evidence of the former size: or again, they would more *abruptly contract*, and consequently form an inner ledge concentric with the outer walls, and perhaps also other concentric ledges still smaller.

This is well illustrated in the figures, and nothing could better indicate the mode of action which characterizes the moon's craters, for we may trace out the successive diminutions. In *Heinsius*, (figure 3,) which is forty-eight miles in its longer diameter, this is beautifully shown; there is one low ledge within another nearly concentric, and finally a smaller circular pit, of twelve miles breadth,—no mean size, though we call it small. An outer concentric ridge is also apparent through part of its circuit, which may have been a still earlier outline; and being lower than the ridge next within, it illustrates the statement, if the hypothesis be true, that the larger craters have lower walls. It is however possible that it may have resulted from a subsi-

* The elevation theory of Von Buch has been supported from facts in the moon. We offer nothing here on that subject.

dence in the area around, as has happened at Kilauea. The same facts are shown by the mountains *Abulfeda* and *Timocharis;* and we have already remarked that the crater of the last mentioned has very nearly the features of the Kilauea pit. Again they might finally so far diminish their size by the cooling in progress, that there would no longer be free ebullition, and the vapors having to force their way up, would break through with explosive violence, producing an alternation it may be of cinder and lava eruptions, or cinder eruptions alone at summit, and raising up conical pointed peaks. These different phases, in connection with fissure eruptions and upliftings from contraction, from both which causes ridges might result, give us a complete and comprehensive view of the origin of the moon's features.

*Are the lunar craters still active?* To a very great extent the surface has evidently cooled, and whether there are any active points is a matter of doubt. But without admitting igneous action at the present time in some parts, how can the facts mentioned with regard to the difference in the light of different portions of the moon's surface (p. 341) be satisfactorily explained? This difference may possibly be partly accounted for on the ground, (borne out by Kilauea,) that the bottom of a crater may have a smoother surface than the declivities or plains exterior. Perhaps also there is something attributable to a difference of material, though this is not probable. If these explanations are received as sufficient for the craters, they fail of satisfying us with regard to the light streaks which are so remarkable about some cones—coursing over ridges and depressions without interruption. The fact of illuminated walls to a crater when the bottom is not illuminated, and the general diffusion of light when one or more bright areas of small extent may be distinguished, are also points not easily understood on the above suppositions. May it not be, that we should attribute some of the instances of lighted areas to a covering of vapors from the igneous action beneath? The light streaks are not depressions, and therefore not broad fissures having the great width they exhibit; but they may be *regions* containing many fissures from which vapors are escaping, and by the coalescence of such areas, the summit of a crater like *Euler* might appear illuminated. Such vapors might so cover the bottom of a crater that the walls would appear brightest. Moreover they might leave the cones within a crater

still distinct; for if spread out at a height of five hundred feet above the bottom, they would still in many instances be more than ten thousand feet below the summit, and far below too the tops of interior peaks.

As there is little or no water in the moon to aid volcanic action, sulphur has probably played an important part in its igneous changes; for this is not only a prevalent means of igneous operations on our globe, but occurs in meteoric stones, pyrites being one of their common constituents. We may therefore believe that, wherever there is action in the moon, sulphur and any other vaporizable material present, are constantly escaping either as simple vapor or in some gaseous combination, and forming a very low covering over certain portions.

As we have observed, the existence of actual volcanic eruption in the moon is still doubtful, and we must look to new facts to settle the point. But we cannot doubt that the surface in *former* periods has been everywhere in violent action, and that its pools of fire were once measured by scores of miles instead of by hundreds of yards, as with our existing volcanoes. And many of these immense basins remain still open for examination, presenting indications of the various changes which accompanied the gradual decrease of igneous action during the cooling in progress. A map of the moon, if there is any truth in these views, should be in every geological lecture room; for no where can we have a more complete or more magnificent illustration of volcanic operations. Our own sublimest volcanoes would rank among the smaller lunar eminences; and our Etnas are but spitting furnaces.

In continuation, I would ask attention to some thoughts bearing on our own planet, which are suggested by this study of the moon's surface.

I. If the earth was once a melted globe, it must have passed through the same phases as the moon, with this *very important difference*, that the whole surface during its progress was subject to the denuding action of waters, and from the first had valleys and sedimentary rocks in progress. It must have had originally its boiling pools of vast extent; which as the action decreased in violence would more or less gradually contract. Are there any remains of these great craters? Or have they disappeared by a decrease in the volcanic action and thus graduated into existing

mountains, or have they been swept away by the changes of time? M. von Buch has described a circular area on the island of Palma, one of the Canaries,* six miles in diameter, which has been compared to a lunar crater, with some appearance of reason. It is in fact hardly twice the diameter of Kilauea, which it otherwise resembles. On Mauritius there is a similar area fifteen miles in diameter, surrounded by precipitous walls composed of the edges of strata dipping outward.† Either it is a volcanic mountain whose centre has fallen in, as suggested by M. Bailly, or it is the remains of a great pit-crater. I merely state the fact without expressing an opinion. Other instances might be mentioned, but this will suffice. At the present period, few active boiling pits remain, and Kilauea is the only one whose characters have been well determined. The surface fires of the globe have so far subsided in action, that in nearly every existing volcano, cinder-ejections characterize the action at summit, and eruptions of lavas in streams are confined to fissures through the sides and flanks of the mountain.

II. We are led by the facts displayed, to remark also on the *origin of the mineral constitution of igneous rocks.*

It has been a difficult problem for solution, why volcanic regions should have a centre of solid feldspathic rocks, unstratified and compact, while the exterior consisted mainly of basaltic lavas. Scrope, Von Buch, and other writers on volcanoes, have mentioned instances of this structure; and it seems to characterize generally the large volcanic mountains. It is well exhibited when the elevations are cut through by gorges; and when not, the clinkstone appears often at the summit of the cone or dome. The explanations we here venture, proceed on two principles:

1. *The motion which belongs to a boiling fluid.*
2. *The less fusibility of feldspar than the other ingredients.*

In the great boiling pools, there will necessarily be a rising of the fluid, in the hotter part, and a flow away towards either side, producing a kind of circulation. This is no hypothesis, as the fact may be witnessed in any boiling cauldron; and the lavas of Kilauea are a visible example of it. The ebullition in lavas

* Desc. Phys. des Iles Canaries. Paris, 1836, p. 281.

† Darwin's Volcanic Islands. London, 1844, p. 30.

on the earth, proceeds principally from the vapors of water and sulphur, which are constantly rising through them, inflating them more and more as they ascend, and finally escaping in bubbles at the surface. Now the feldspar being the less fusible part of the lavas, would thicken somewhat, wherever the temperature became too low for complete fusion; the more liquid portion would then ascend most easily, being carried along by the inflating vapors, and much of the feldspar would thus be left behind, and it might be in a nearly pure state. The centre of the volcano under this action, becomes necessarily feldspathic. The summit might therefore eject either basaltic or feldspathic rocks from the material of the vent; though when the action was violent and deep, it would eject feldspathic rocks alone.

At the same time the *basaltic* lavas, descending laterally in this system of circulation along the sides of the great central conduit, may pass out as flank eruptions through fissures. Besides, there will also be basaltic ejections from sources of lavas at a distance from the central conduit, where they have not been subjected to the separating process described; and this may be the more common source.

Mountains with a feldspathic centre, and basaltic layers forming the circumference, are therefore quite intelligible without supposing the feldspar to have been first thrown up, or appealing to a different system of fissures for their origin, and the examples which the moon presents, are more extensive than is necessary to explain the widest facts on the earth.*

In these remarks we have spoken of the lavas as consisting mainly of feldspar and augite, their more common constitution; but we use the terms in a general sense, understanding by feldspar one or another of the feldspar family of minerals, and by

* It is common to say that certain domes of trachyte were thrown up in a *pasty* or imperfectly fluid state,—in order to account for the fact that there is no appearance of the rock's having flowed in streams. Without intending to refer the origin of these domes to any particular cause, I would suggest the query, whether, if their formation was subaërial, this *pasty* state does not necessarily imply that the ascending vapors would have found some difficulty in escaping, and would have broken through with explosions, as explained in the foregoing pages; and consequently that there would have been scoria and cinders accompanying the ejections? or may we believe it probable, that the paste was so dense that water would not make its way up and escape as vapor? Is this last supposition borne out by any existing example of subaërial volcanic action?

augite the remaining fusible material, whether ordinary augite (silicate of lime, magnesia and iron) or silicates of one or more of these bases or alumina in other combinations.

There is some difficulty in applying this hypothesis to particular cases, on account of our ignorance of the actual fusibilities of the materials of the lava, in the condition in which they are placed; for we know that an infusible mineral may be held in fusion under certain circumstances, or with certain mineral associations, far below the temperature at which it fuses: or, previous to the commencement of cooling it may be in some other combination.

We should infer that the process which separates the feldspar, would also separate any excess of the more infusible mineral quartz. This may not follow: still it is a remarkable fact that the quantity of quartz contained in trachyte is often in great excess, as analyses have shown. But why is not the infusible mineral chrysolite also detained? The fact appears to be, that it is of subsequent formation. The small proportion of silica it contains implies a deficiency of this substance, while, as we have stated, in the feldspathic rocks there is often an excess. It may, therefore, under certain circumstances proceed from the basaltic material, for its elements are the same in different proportions. Subsequent investigations may give us more light on this point.

The general principle which we have above brought forward, is well illustrated in the fact that the scoria or surface glass of any vent, where it occurs, is the most fusible part of the lava, consisting in general of ferruginous or alkaline silicates, and containing no magnesia. On account of the diminished heat, this material alone remains sufficiently fluid to be inflated and borne up to the surface by the rising vapors: and this takes place in spite of superior gravity.

We hence comprehend the *rapid cooling* which characterizes ejected lavas, *for only a part of the material is in complete fusion.*

The actual nature of the *cooled igneous rock* may be more correctly understood, if we consider that the minerals present will depend, not only on heat and pressure and the causes above alluded to, but also on rate of cooling. The effect of slow cooling is exemplified in the feldspathic centre of a volcanic mountain. Being wholly enclosed by rocks, the heat of fusion passes off slowly, and owing to the pressure of its own superincumbent

portions, the rock is compact. Whatever augite may be present, instead of appearing as augite, will take the form of hornblende, a mineral which requires slow cooling, and differs from augite in the crystalline form which it thus receives. In corroboration of this statement, hornblende is common in trachytes and such feldspathic rocks. The same remarks apply to mica: and other minerals also may form according to the elements present. Chrysolite is not met with: it occurs only where there is a more rapid rate of cooling, as in the formation of ordinary basaltic rocks or lavas.

Farther we observe that with a still more gradual rate of cooling, the whole feldspathic rock becomes crystalline in texture like a granite or syenite, and it is well known that granite-like or syenitic rocks or peaks occur in some volcanic regions, whose interior has been laid open by denudation. Many minerals too might crystallize under these circumstances, which with more rapid cooling would not be distinguishable.

The boiling process in a large volcano, therefore, in connection with the circumstances of temperature, rate of cooling, the fusibilities of different minerals, and the other causes alluded to, will account for the various features, positions and relations of igneous rocks, and for many facts relating to the distribution of igneous minerals.* We may hence reasonably infer that granite and granite minerals may form under the same circumstances, if the elements are present in the material in fusion; for the syenites alluded to are closely allied rocks in texture and character. At a former meeting of this Association, it was suggested by me that *some* regions of granite peaks may have been centres of ancient igneous action; and their being surrounded or bordered by hornblendic rocks, seems to point to some actual analogy with the trachytic centres and basaltic circumference of mountains admitted to have been volcanic.

The opinion that the nature of the resulting rock is directly connected with the nature of the rock which had entered into fusion, cannot be maintained if the above views be true. On the contrary, it appears that while the result may thus be varied, the

* The general causes referred to, act under the guiding laws of crystallogeny, which laws regulate the particular positions of minerals according to the principles exemplified in segregations or radiated crystallizations, and the laminated or cleavable structure of igneous rocks.

mode of distributing minerals in a volcanic focus by the boiling process, may produce from the same material, rocks of a predominant feldspathic character in one place, and rocks of a hornblendic or augitic character in other places. Simple feldspathic granites may be fused and ejected as feldspathic rocks, like those of porphyry dikes. But it is an interesting fact, that the rock of most dikes is of the augitic (or hornblendic) kind, like the dikes of volcanoes that rise from sources in which the *separating* process could not have been operating.*

We also arrive at the important conclusion, that rocks perfectly compact in texture may be of subaërial origin, as we have pressure from the fluid lavas themselves in the volcanic focus.

Another deduction proceeds from the facts stated;—that the same igneous rocks may occur of all ages, provided the atmosphere or waters of the earth were not too warm for the more rapid rate of cooling required for uncrystalline rocks. Scorias, basalt, trap, porphyry, syenite, granite, have no relations to one epoch rather than another, beyond what may depend on the circumstance just mentioned. Whenever therefore in the history of the world, the variations in heat, pressure, and rate of cooling, now possible, may have taken place, similar rocks to those of the present day may have been in progress:—and as far as the variations of former times, in these respects, may now take place, former rocks and minerals may still be in progress. In this statement it is implied that the necessary elements are present in the fused material.

III. *Origin of Continents.*—The moon gives us hints on another topic of great interest, relating to the distribution of land and water on our globe. We have mentioned that there is a large area covering nearly one third of the hemisphere facing the earth, which is mostly free from volcanoes, while on other parts the craters are closely crowded together. We may therefore reason-

* Mr. Darwin has accounted for the distribution of feldspathic and augitic rocks in volcanoes, on the ground of their different specific gravity. But with this cause alone, the lower parts of the feldspathic peaks should be expected to contain the heavier augitic material, which is not the case. He also argues that the feldspar would rise in the fluid as crystals, and so the augite sink. But we know in the first place, that crystals do not appear till incipient solidification, and if the augite and feldspar were both in distinct crystals, where would be the fusion? Again, the feldspar rocks are *amorphous*, except with a very slow rate of cooling; and how then can the existence of appreciable crystals be assumed?

ably infer, that over this naked portion, the surface first became solid, and has therefore cooled the longest and to the greatest depth. Consequently, the contraction from cooling, which was going on, would take place most rapidly over the thinner and more yielding volcanic portion; and unless the ejections made up the difference, this part would become somewhat depressed. A melted globe of lead or iron in the same manner, when cooling unequally, becomes depressed by contraction on the side which cools last. Now on our own globe, the continents have to a very great extent been long free from volcanic action. A glance at a map of Asia and America will make this apparent. It is usual to attribute this almost total absence of volcanoes from the interior of the continents to the absence of the sea; but it is fatal to this popular hypothesis, that the same freedom from volcanoes existed in the Silurian period, when these very continents were mostly under salt water, a fact to which the wide spread Silurian rocks of America and Russia testify. Over the *oceans*, on the contrary, all the islands excepting the coral, are igneous—and the coral may rest as we have reason to believe on an igneous base.

It is therefore a just conclusion that the areas of the surface constituting the continents were first free from eruptive fires. These portions cooled first, and consequently the contraction in progress affected most the other parts. The great depressions occupied by the oceans thus began; and for a long period afterward, continued deepening by slow, though it may have been unequal, progress. This may be deemed a mere hypothesis; if so, it is not as groundless as the common assumption that the oceans may have once been dry land, a view often the basis of geological reasoning.

Let us look farther at the facts. Before the depression of the oceanic part of our globe had made much progress, the depth would be too shallow to contain the seas, and consequently the whole land would be under water. Is it not a fact that in the early Silurian epoch nearly every part of the globe was beneath the ocean? So we are taught by the extent of the formations. The depth of water over the continental portions would be very various; but those parts which now abound in the relics of marine life, were probably comparatively shallow, as amount of pressure, light, and dissolved air, are the principal circumstances influencing the distribution of animals in depth, and acted former-

ly, we may believe, as at the present period. Here then we see reason for what has been considered a most improbable supposition, the existence of an immense area covered in most parts by shallow seas and so fitted for marine life.

If we follow the progress of the land, we find that with each great epoch there has been a retiring of the sea. In the coal deposits we have an abundant land vegetation. Subsequently, the progress on the whole was giving increased extent and height to the land and diminishing the area of the waters. Instead therefore of a bodily lifting of the continents to produce the apparent elevation, it may actually have been a retreating of the waters through the sinking of the ocean's bottom. The process however has not been a continuous one: for during each epoch,—the Silurian and the more recent,—there have been subsidences as well as seeming and actual elevations, and various oscillations of the continental surface, from subaërial to submarine and the reverse. When contraction had once taken place over the continents as well as under the ocean, there may have afterwards been expansions again through the return of heat from some cause. And thus various irregularities have taken place, such as the rocks indicate. In the tertiary period and since, the apparent rise of the land has been still to some extent in progress. And is there any evidence that this could have arisen from a sinking of the ocean's bed? The evidence is undoubted. For Mr. Darwin has shown satisfactorily, (and farther observations to the same end, and to many interesting conclusions, will be presented in the writer's geological report on the Pacific), that a subsidence of some thousands of feet has taken place since the corals commenced their growth. Every coral island is a register of this subsidence.*

And why should not the ocean's bottom subside, as well as the land? What has given the continental portions of our globe their elevation, as compared with other parts, if not the unequal contraction of the whole? Can we safely affirm—in words of high authority—"that the stability of the sea and the mobility of the land are demonstrated truths in geology,"† when mobile land forms also the bed of the ocean, and its changes must affect the

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* See Silliman's Journal, xlv, 131, 1843.

† Leonard Horner, Esq., Anniversary Address before the Geological Society of London, January, 1846; Quarterly Jour. of the Geol. Soc., No. 6, p. 199.

stability of the superincumbent waters; I ask, can we safely make this affirmation, until we know something more certain than past investigations have revealed, about the geological history of the two-thirds of the surface of our planet that are concealed beneath its oceans?

In our conclusion from the above reasoning, we fall in nearly with the views presented by a distinguished French geologist, M. C. Prevost, who has argued with much force in favor of subsidence as a cause of the apparent elevation of the land: though it may be right to state that these conclusions were arrived at previously to seeing his memoir.* There appear to be many objections to the opinions of M. Prevost, as they are expressed by him, inasmuch as no allowance is made or admitted for minor disturbances and actual elevations by subterranean forces. His views however are well worthy the attention of the geological enquirer.

The principles explained place the general theory of change of level by contraction upon something better than a hypothetical basis, and are believed to explain the actual causes by which the changes have been produced. They correspond moreover with the view that ruptures, elevations, foldings and contortions of strata have been produced in the course of contraction. The greater subsidence of the oceanic parts would necessarily occasion that lateral pressure required for the rise and various foldings of the Alleganies and like regions.

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* The general theory of changes of level by contraction and expansion, and the rise thus of continents, was first presented by Mr. Babbage and De la Beche. M. C. Prevost takes the different ground that all seeming elevations are the result of subsidence. His propositions are as follows, (Bulletin de la Soc. Geol. de France, xi, 1839 à 1840, p. 186):—

"1. Que le relief de la surface du sol est le résultat de grands affaissements successifs, qui, par contre-coup, et d'une manière secondaire, ont pu occasionner accidentellement des élévations absolues, des pressions latérales, des ploiements, des plissements, des ruptures, des tassements, des failles, etc.; mais que rien n'autorise à croire que ces divers accidents ont été produits par une cause agissant *sous le sol*, c'est-à-dire par une force soulevante;

"2. Que les dislocations du sol sont des effets complexes de retrait, de contraction, de plissement et de chute;"

"3. Que les matières ignées (granites, porphyres, trachytes, basaltes, laves,) loin d'avoir soulevé et rompu le sol pour s'echapper, ont seulement profité des solutions de continuité qui leur ont été offertes par le retrait et les ruptures, pour sortir, *suinter* et s'épancher au-dehors."

ART. XXXI.—*Description of three varieties of Meteoric Iron.* —1. from near Carthage, Smith County, Tennessee; 2. from Jackson County, Tennessee; 3. from near Smithland, Livingston County, Kentucky; by G. TROOST, Prof. in the University of Nashville, Tennessee.

1. *Meteoric Iron from Carthage, Smith County, Tennessee.*

IN vol. xlix, p. 336, of this Journal, I published a description of four varieties of meteoric iron, one of which was of the highest interest as its fall had been witnessed by several persons. My collection has since been augmented by three other newly discovered specimens. A friend of mine, Samuel Morgan of Nashville, learned sometime in 1844 that a large mass of some metal had been found in Smith County near Carthage, Tennessee, which was considered as silver, and a small sample of it was given to him which we both recognized immediately as meteoric iron. Mr. Morgan immediately endeavored to learn its history and to get possession of it; but as I observed above, it being considered a precious metal, he failed, and every thing was enveloped in mystery, till it became known that it was not silver. He learned then that it was in the possession of a blacksmith, that it was found about a mile from Carthage the County seat of Smith County, and Mr. M. obtained it last year for a moderate price. It weighed 280 pounds—an oblong shapeless mass, its surface showing here and there some projecting octahedral crystals. A piece of it was sawed off weighing 39 lbs. which now forms one of the ornaments of my cabinet. This magnificent specimen has a polished surface of about 12 by $9\frac{1}{2}$ inches. None of the metallic meteorites, that I have seen, exhibit such beautiful Widmannstattean figures which have become visible on its polished surface, without the aid of acid. It shows rhomboidal and triangular sections which are generally a full inch, and a few, more than an inch, in length. These figures cover uniformly the whole of the polished surface. No heterogeneous materials are visible in it. There is only one cavity of about $\frac{1}{2}$ inch on its surface.

The unpolished part is partly crystallized and partly amorphous and compact. Some crystals (parts of octahedrons) project for more than an inch above the mass. The iron is very tough and malleable, and, as it contains no traces of pyrites, not susceptible

of being acted upon by atmospheric agencies. A partial analysis has convinced me that it contains a notable proportion of nickel; the other components I have not ascertained.

### 2. *Meteoric Iron from Jackson County, Tennessee.*

I am also indebted to my friend, S. Morgan, for the knowledge of a variety of meteoric iron which is found in Jackson County in this state. Mr. M. received only a sample of it, but its history, quantity and locality are still kept in profound secrecy, as it is yet considered as silver and its owner is looking out for its original deposit. The piece in my possession weighs 15 ounces. It is an accumulation of large crystals, some of an octahedral, others of a tetrahedral form—of a very soft malleable iron. Its bold and solid crystals distinguish it from the other Tennessee meteoric iron.

It was accompanied by some fragments of the crust of meteoric iron weighing $3\frac{1}{6}$ ounces. It is a hydroxide of iron of a brown and yellow color, penetrated here and there with metallic iron and resembles the crust of the Sevier County iron; but the iron itself differs very much from the last named iron. This crust and the bold crystalline structure, shows that the original mass must have been large.

### 3. *Meteoric Iron from Livingston County, Kentucky.*

Some six or seven years since a piece of metal was handed me with the request that I would see how much silver it contained. When I told the person, who showed it, that it did not contain silver and was only iron, he became displeased and departed without answering my queries as to its locality, quantity, etc. Some years after I received another piece of it from a different person. I convinced him that it was iron, but all the information I could obtain was that an abundance of it was found, and as he intended to purchase the land on which it occurred, he refused to mention the locality but promised to send me a large piece of it. The man did not keep his promise and I have not heard of him since. But some time last year Colonel Player of Nashville mentioned to me that he had the offer of a tract of land on which such iron ore (showing the identical meteoric iron) was found in abundance—he thought it was ore of an excellent quality—that it did not require any preparation and could

be worked in the same state it was found in, showing me a cold chisel made of it. I told him to examine the land and see whether an abundance of it really did exist, mentioning at the same time, that I was convinced that but a single, or at least very few pieces of it could be found, because it was meteoric iron, which, so far as is known, falls only in single masses. Colonel Player went to the spot and then learned that only a single piece of it had been found. From this gentleman I learned that the original piece was pretty large but that it had been cut up and worked in the blacksmith shop; that the only piece now existing in its natural state, and which he had in his possession was of about 8 or 10 pounds; part of it, together with the cold chisel mentioned above, is now in my possession.

This piece weighs $4\frac{3}{4}$ pounds. It is a remarkable variety, has a fine granular fracture, similar to that of steel, is very compact, and has no traces of crystals, or of a crystalline structure. It is a shapeless mass and has a rough surface, where it has not been cut—it has the properties of steel; in fact the above mentioned chisel is equal to one made of cast steel. An incomplete analysis has given me 10 per cent. of metal mostly nickel. It was found near Smithland, Livingston County, Kentucky.

Nashville, Aug. 17th, 1846.

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ART. XXXII.—*A Sketch of the Geology of Texas;* by Dr. FERDINAND RŒMER. (In a letter to the Editors dated New Braunfels, German settlement on the Guadaloupe, in Western Texas, Comal County, June 12, 1846.)

DURING the four months which I have already passed in Texas, my time has been employed in the study of its geological relations: and although my knowledge of the country is yet incomplete and mostly confined to the western section of the territory, I may hope that the following sketch of what I have seen, considering the little that is known, will prove of interest to your readers, and afford a basis for further investigations.

It is not a very encouraging fact to the geologist in Texas, that only there, where civilization ceases and the wilderness commences, the geological relations of the country begin to be interesting. The line which separates the settled part of the country

from the hunting grounds of the Indians, is almost exactly identical with that which divides the more modern diluvial and alluvial deposits from the secondary formations. The three points, lying in the same straight line, San Antonio di Bexar, New Braunfels, (the German settlement on the Guadaloupe,) and Austin, are alike the extreme frontier parts of Western Texas, and the limit of the cretaceous deposits of the upper country towards the southeast. In the few observations which I have to make, I shall therefore separate the particulars relating to the lower country from those bearing upon the secondary formations in the section of country lying beyond the just mentioned line.

The route by which I reached the northwestern section of the country, leading through Houston, San Felipe, Austin, Columbus on the Colorado, Gonzales and Seguin, is nearly devoid of any geological interest; you see no solid rock in place through the whole distance, excepting irregular layers of a coarse calcareous sandstone of very modern origin, exposed on the steep banks of some of the rivers. The surface is elsewhere a thick diluvium of loose materials consisting either of a fertile vegetable mould, or of rounded pieces of hydrate of iron—as over the barren section between San Felipe and Columbus—or of sand and gravel, as near Gonzales and elsewhere.

The gravel and sand are of some interest on account of the abundance of fossil wood which they contain at many different places. I saw numerous localities of it between San Felipe on the Brazos, and Gonzales, and in the valley of the Colorado between La Grange and Austin. This petrified wood is often found in large pieces, and it is said that occasionally whole trunks of trees are met with, which however I have not myself seen. The fossilization of the wood is generally imperfect, the silex into which it has been turned showing most minutely the original structure. Most of the wood is dicotyledonous; but not having the leisure or the necessary books of reference, I have not made out the species. I have only observed that in some of the wood the fibres are extremely close, and the whole structure very compact, exceeding any tree in the existing flora of Texas.

As the gravel and sand in which most of this fossil wood occurs is generally covered by post oak timber, which alone grows on a soil of such sterility, it is a common belief among the farmers of the country that the fossil wood was derived from simi-

lar oak trees of earlier growth in the same region. But this is evidently a mistake, as the fragments bear distinct marks of having been rolled and transported by water; and the question arises as to the geological formation in which this wood was originally deposited and petrified. The gravel where it occurs consists chiefly of rounded pebbles of silex, mostly of a reddish color and of a similar appearance to the silex of the cretaceous formation in the upper country. This might lead to the supposition, that the wood as well as the pebbles derive their origin from cretaceous strata. But it is an objection to this view, that no remains of dicotyledonous plants (the Coniferæ and Cycadeæ excluded) have hitherto been found in strata older than the tertiary deposits, excepting the leaves of *Credneria* in the green sand of Germany; and moreover, the fossil wood becomes scarce as you approach the hilly country where the cretaceous strata are in place. We may hope that the doubt will be removed by an examination of the eastern section of the country, where the fossil wood is said to be still more abundant, and where according to Kennedy,* between the Trinity and Nueces rivers, great numbers of petrified trees lie imbedded in the soil.

The thickness of the diluvial beds diminishes when you approach the cretaceous deposits, and when you are near the abovementioned line the cretaceous strata begin to show themselves in the deep ravines and gullies; but they do not appear at the surface until you pass that line. At the same time the topographical character of the country entirely changes. Instead of the low undulations of the prairies, hills of considerable height with sharply defined outline, and but a short distance beyond, real mountain ranges show themselves to the north, marking the limit between the rolling and mountainous region of Texas.

The place where I first met with a cretaceous deposit was at New Braunfels, exactly where the old Precidio road from San Antonio to Nacogdoches crosses the Guadaloupe. Here in the bed of the river a white limestone is exposed which looks very similar to the "chalk marl" of England, and to the "plänerkalk" of Saxony. It is white, rather compact, in some beds more marly, and occasionally it contains green particles of silicate of iron. The stratification is perfectly horizontal. Some of the

* Texas, Vol. I, p. 119.

strata abound in fossils. The most common species is a small Ostrea, similar to *Ostrea vesicularis*, Lamk., but never growing as large and generally not being more than one inch in diameter. Next to it comes a large species of Exogyra, analogous in form to *Exogyra costata*, Say, but having concentric laminæ instead of the oblique folds of that species. It certainly is the largest species of the genus, as some specimens of it are more than nine inches in length. Equally common with this Exogyra, there are two species of Inoceramus, one of them being similar to the *Inoceramus Cuvieri*, Sowerby, and the other to the *Inoceramus cripsii*, Mantell. The *Pecten quadricostatus*, is also abundant in some beds, a characteristic fossil, widely spread in cretaceous deposits. Of the large family of the Brachiopoda, I saw but a few specimens of *Terebratula gracilis*. The family of the Cephalopoda is not better represented. I saw two species of Ammonite, one of them of the section which the *Ammonites varians* belongs to, and a Nautilus, which certainly is nearly allied to the common *Nautilus simplex*, if not identical with it. In one stratum which is only about five inches thick, sharks' teeth of the genus *Lamna* and other genera abound.

The same limestone ranges very far on both sides of the Guadaloupe, and every where parallel to the chain of high hills or mountains which separate the Indian country from the settled part of Texas. On one side I have followed it as far as Austin on the Colorado. The hills, on the slopes of which this city is so handsomely situated, consist of limestone with the same mineralogical and organic characters as that on the Guadaloupe. Among the fossils I found here a large Ammonite similar to the *Ammonites Rhotomagensis*, Sowerby. Near Austin also a single specimen of the *Exogyra costata*, Say, was met with. It seems that this species among the fossils of the North American cretaceous formation has the widest range. Besides its most abundant occurrence in the cretaceous marl of New Jersey and at some places in the Southern States, it is mentioned by Featherstonhaugh* to be frequent at different localities in the State of Arkansas.

From several facts I have obtained, it is certain that the same limestone extends beyond Austin much farther to the northeast.

* Excursion into the Slave States, p. 119.

On the other side of the Guadaloupe, the limestone is exposed in many places on the road from New Braunfels to San Antonio, which leads in a southwestern direction. Where the road crosses the Cibolo, the limestone forms in the bed of the river singularly shaped rocks, through which the water has eaten its channel, and which are teeming with fossils. At San Antonio the limestone is opened by several stone quarries, and the far famed Alamo mission has been built of it. West and south of San Antonio, I have not yet seen the limestone myself, but I have reason to believe that it extends much farther in both directions. A specimen of the same Exogyra which abounds on the Guadaloupe, was brought to me and said to have been found among the pebbles in the bed of the Rio Grande.

Besides this white marly limestone, there is another series of strata to be described. Ascending, from New Braunfels, the range of steep hills which stretches to the northwest of this place, as soon as you leave the level of the valley, horizontal strata of a compact yellowish limestone are seen, resembling very much the compact limestone of Italy, and of Southern Europe in general. Some of the strata are very siliceous, containing large compressed nodules of pure dark colored silica. Other beds are so soft that they easily decompose through the action of air. Where limestone is very compact, hardly any trace of fossils is seen in it, but some of the looser strata abound with shells. Among them there is a small species of Exogyra, which for its prominent, spiral beaks and general shape might easily be mistaken for a species of Chama or Diceras; it is very common, and in some localities occurs in great abundance. Together with this Exogyra, there is in most places a new species of Gryphæa; also a smooth and globose Terebratula, and occasionally a specimen of *Pecten quadricostatus*. These beds of soft marly limestone are not only seen every where on the mountains in the neighborhood of New Braunfels, but they extend north of this place about seventy miles as far as to the Piedernales river, every where containing the same fossils. Over the same wide range, there are other fossiliferous strata of an entirely different character. I saw them first in a deep ravine near the narrow rock-bound channel of the Guadaloupe, eight miles north of New Braunfels. One thick bed of compact limestone contains, in immense numbers, certain organic bodies of cylindrical shape. These fossils are

generally an inch or two in diameter, twisted both ways, and mostly furrowed longitudinally on the surface. At first view I was rather puzzled as to their relations, but on closer inspection of their internal structure, it became evident that they must belong to the order of the Hippurites, that singular division of shells which gives the peculiar fossil character to the cretaceous formation of Southern Europe, from Lisbon in Portugal as far as Asia Minor along the Mediterranean. Some beautiful specimens of a real Hippurites resembling very much a species of Southern France, were afterwards met with. In the same beds of limestone with these Hippurites, several species of bivalve shells are found which belong to genera equally characteristic of the Mediterranean cretaceous formations, viz. Diceras and some analogous genera. At last in the same beds also occur a large Pecten of the same section as the Pecten quadricostatus, besides several univalves.

Some Hippurites and several species of the Diceras family, were also found on the Piedernales; so that it seems probable that the strata just described have a very extensive range.

Having presented the facts observed, I offer a few general conclusions from them. At first there cannot be the least doubt that all the strata just described are equivalent to the cretaceous formation of Europe. The identity in the general character of the fossils incontestibly proves it. It is more doubtful to which division of the cretaceous formation they ought to be referred. So much however is certain *a priori*, that they do not represent the lowest divisions of the cretaceous system; since among the organic remains there are no characteristic fossils of the lower green sand or of the gault. The fossils of the white marly limestone first mentioned indicate an age not older than that of the "chalk marl" of England in the series of the cretaceous deposits of Europe. We might even be inclined to believe those strata equivalent to the white chalk of Europe, if some of the most characteristic fossils of the chalk among them especially the *Belemnites mucronatus* were not wanting altogether. The system of strata partly consisting of compact siliceous limestone, and containing fossils of the Hippurite order, next described, belong still higher in the European series; for near New Braunfels they certainly lie above the marly limestone. From some observations however made at other localities, I have reason to believe that the two systems of strata are not every where so distinctly sepa-

rated, and form together a single continuous succession of strata of nearly the same age; and with regard to the age we can at present only say that the beds belong to the upper division of the cretaceous formation. It is interesting to compare these cretaceous deposits with the cretaceous strata of New Jersey, Virginia, etc. In the latter regions we find beds of a loose calcareous marl and of ferruginous sand, representing the upper division of the cretaceous formation. In their fossils and also their mineralogical constitution they bear a striking analogy to some deposits of England and Germany. In Texas, we have a system of rocks which equally correspond to the upper division of the cretaceous formation, but of a very different character and not consisting like those just mentioned of loose unconnected materials, but partly at least a very compact siliceous limestone. By their fossils as well as the composition of the rocks they are closely allied to the cretaceous formation as it is developed in the south of Europe along the Mediterranean.

A new and interesting analogy in the geological constitution of the two continents has thus been ascertained, proving the general similarity of physical condition and of the laws of organic life in both hemispheres during the period when the cretaceous strata were originally deposited.

Still another observation of a general character remains to be stated respecting these cretaceous deposits. About 20 miles north of Fredericksburg, the new German settlement on the Piedernales river, a rock more than one hundred feet high with nearly perpendicular sides stands out from the ground. This rock which very probably is identical with that which has been laid down on the maps of Wilson and others as "the enchanted rock," consists of a rather coarse grained granite. I obtained specimens of the granite from some friends of mine who were on the spot, and ascertained also that beds of limestone extended to the very base of the rock. This fact in connexion with the other one that on the San Saba river, silver mines have been worked formerly by the Spaniards in a plutonic rock, seem to lead to the supposition that here on the tributaries of the Colorado we arrive at the boundary where the stratified rocks of the east side of the continent come in contact with the crystalline masses of the Rocky mountains. If this supposition is correct, it follows that the cretaceous formation is the only one of the whole series of

stratified rocks which exists in this part of Texas. From the facts observed in Texas, we derive additional confirmation of the hypothesis long since made with great sagacity by M. Leopold von Buch and never refuted, that the oolite series of Europe have no equivalent on the American continent.

In the course of this summer I hope to extend my investigations to other parts of the country, and may be able then to give your readers some more satisfactory information about its geological relations.

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ART. XXXIII.—*Fusion of Iridium and Rhodium;* by R. HARE, M. D., Prof. of Chemistry in the University of Pennsylvania.*

THIS communication respects mainly my success in fusing both iridium and rhodium, neither of which in a *state of purity*, had been previously fused. It may be supposed that the globule of iridium, obtained by Children's colossal battery, forms an exception; but the low specific gravity, and porosity, of that globule, may justify a belief that it was not pure; and at any rate, the means employed were of a nature not to be at command for the repetition of the process—so that iridium might *as well be infusible*, as to *be fusible only by such a battery.*

The first specimen of the last mentioned metal, on which I operated, was one given me by Mr. Booth, a former pupil of Wöhler, whom he had assisted in obtaining it by the excellent process devised by that distinguished chemist. This specimen

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*TO THE EDITORS.

*Gentlemen*—The facts and observations of which the accompanying communication is intended to give an account, having been communicated, as they occurred, at the meeting of the American Philosophical Society, were published in subsequent numbers of their bulletin in the spring and summer of 1842. Excepting in that work, I believe they have not yet been published. Under these circumstances, I trust that a communication embodying the statements made before the Society as above mentioned, may be deemed worthy of republication in your Journal. I have lately allowed Mr. Goetz, one of the contributors to the "Revue Scientifique," published at Paris, to make therefor a translation of this article, accompanied by a suitable letter to the editors.

I am, gentlemen, with esteem, yours very truly, R. HARE.

was fused in the presence of Mr. Booth. Subsequently I procured specimens, warranted pure, severally from the house of Pelletier at Paris, and from Messrs. Johnson & Cocke, London. Another specimen was given to me by a friend, who had received it as pure, from a source on which reliance may be placed; and lastly, I obtained myself, by Wöhler's process, a specimen of about sixty grains, from the insoluble residue of platinum ore. All the specimens thus procured, were found to be fusible under my hydro-oxygen blowpipe. The specimen obtained from Johnson & Cocke, after repeated fusions by which it was much consolidated, weighed sixty-seven grains. During fusion there appeared to be an escape of volatile matter, supposed to be osmic acid, arising from the presence of a minute portion of that metal, between which and iridium, an affinity of a peculiar degree of energy exists. At a certain point of the process, a reaction took place sufficiently explosive to throw a portion of the metal, in globules, off from the support. One of these, about twice as large as the head of a common brass pin, proved to be hollow. By prolonged and repeated fusion, the metal became more compact and more fusible.

Fused iridium has nearly the grain of soft cast steel, with the pale whiteness of antimony, and appears to be susceptible of a fine polish. Although as hard as untempered steel, it is somewhat sectile, since when split by means of a cold chisel, the edge penetrated about the eighth of an inch before a division was effected. By light hammering a corner was flattened without fracture, although under heavier blows the mass cracked. I infer that although nearly unmalleable and very hard, iridium may be wrought in the lathe.

I have already mentioned that I fused into a globule a specimen of iridium, obtained by me from the insoluble residuum of platinum ore by Wöhler's process. From this globule, while congealing, a portion ran out from the inside, leaving a cavity and covering one of its sides externally with an incrustation, among which crystalline spangles, or facets, were discernible. The specific gravity of the globule of iridium, from the specimen furnished by Messrs. Johnson & Cocke, was taken by Mr. T. R. Eckfelt, of the United States mint at Philadelphia and by Dr. Boyé, both having balances of the greatest accuracy and being very skillful in the employment of them. In the first in-

stance there was a perfect coincidence in the results obtained, 21·83 being the numbers found by both of these gentlemen. Agreeably to another trial made by Dr. Boyé, using river water instead of distilled, the number was 21·78, water being in either case about sixty-eight with allowance for the difference of the water, and the temperature being above the standard of 60°. The specific gravity of the specimen, may then be estimated at 21·80.

The specific gravity of fused platinum, purified according to the instructions of Berzelius, before subjection to the hammer, proved in one specimen to be not more than 19·70, although by hammering it became equal to 21·23. It is with fused platinum that fused iridium should be compared. Of course the specific gravity of the last mentioned metal when both are obtained by fusion, may be assumed to be one tenth greater than that of the former. Moreover as this metal is the only impurity existing in the standard platinum of London, of Paris, or of St. Petersburg, it follows that a high specific gravity is not to be viewed as a proof of purity. Accordingly a specimen of platinum, purified from iridium by the Berzelian process and which had proved eminently susceptible of being beaten into leaf, was found only to be of the gravity of 21·16, while that of a specimen of standard Russian platinum, very brilliantly white, but inferior in malleability presented to me by his Excellency Count Cancrine, as a specimen of the purest platinum of the Russian mint, was 21·31.

Of rhodium, I have fused two specimens, one of five penny weights, purchased of Messrs. Johnson & Cocke, the other received through the same channel as the specimen of iridium above mentioned*. Rhodium is at least as fusible as iridium, both of the specimens alluded to, having been converted into fluid globules. That procured from Johnson & Cocke, gave a globule weighing ninety grains. On a second fusion, it formed a perfect globule as fluid as mercury; and yet in congealing lost its brilliancy by becoming studded with crystalline facets all over its surface, excepting the portion in contact with the support. The facets had the appearance of incipient spangles. The rapidity with which they were formed seemed to be anomalous. The mass being split by a cold chisel and viewed by a microscope, it

* One other larger specimen from the same source has been fused since the above was written.

appeared porous immediately beneath the facets. When the mass was first fused, I found by the gravimeter the specific gravity to be 11·0, which coincides with the observations of Wollaston. Yet by a careful trial made at the U. S. mint by Mr. Eckfelt, after the second fusion, and the formation of the facet, the specific gravity proved to be only 10·8. This is sufficiently explained by the porosity above mentioned. In fact the porosity to which rhodium and iridium are liable, may render it difficult to find specimens of precisely the same specific gravity.

In sectility, malleability and hardness, rhodium did not appear to differ much from iridium, but it is not of so pale a white as iridium. The one has the pale white of antimony, the other the ruddy hue of bismuth.

Osmiuret of iridium as existing in the native spangles associated with platina ore, or as otherwise obtained, is far more difficult of fusion than pure iridium. The propensity to assume the crystalline form, and to adhere to it, is even greater in this alloy than in the last mentioned metal. On first exposure to the most intense heat of the hydro-oxygen blowpipe, some slight appearances of fusion may be seen, and the spangles or grains may be made to cohere. Nevertheless it yields very slowly, and requires an expenditure of gas too great to be incurred unless it were for the purpose of once well determining the question of its ultimate fusibility. This object was obtained completely as respects a globule of forty-five grains in weight. The specific gravity of this globule appeared to be 20.4, but this result was evidently less than that which would have been obtained had there not been some minute cavities, which after splitting the globule, were detected by a magnifier.

The specific gravity of some large spangles of osmiuret of iridium from South American ore, was by Dr. Boyé found to be 19·835. That of some grains heavier but not so flat, presented to me by Count Cancrine, was found to be 20.938.

That the alloy of iridium with osmium should be more difficult to fuse than pure iridium, leads to the inference that osmium must be the most infusible of the metals, although, like carbon, very susceptible of combustion, and capable, like that infusible non-metallic radical, of forming a volatile peroxide. Of course its liability to oxydizement, would render it impossible to fuse it by the hydro-oxygen blowpipe, of which the efficacy requires the

simultaneous presence of oxygen and the most intense heat. It might be fused by exposure in vacuo to the discharge of a powerful voltaic series, by means of the apparatus of which a description with engravings has been given in a recent volume of the Transactions of the American Philosophical Society, and republished in this Journal for 1841, vol. xl, p. 303.

I have obtained osmium by heating the osmiate of ammonia in a glass tube with sal ammoniac, agreeably to the instructions given by Berzelius. In this way a result was obtained which the information given by that distinguished chemist, had not led me to anticipate. The tube became coated with a ring of osmium, which it would be impossible by inspection merely, to distinguish from the arsenical ring on the peculiar features of which, reliance has been placed for the detection of arsenic.

It follows from my experiments and observations, that of all metallic bodies, osmiuret of iridium is the most difficult to fuse; that rhodium and iridium are both fusible by the hydro-oxygen blowpipe, properly employed; that the former has the rosy whiteness of bismuth, the latter the pale white of antimony; and that both of them are slightly sectile though extremely hard and nearly unmalleable; that iridium *merely fused*, is heavier than platinum *condensed by the hammer*. Thus it follows from my experiments and from the recent observations of Breithaupt, on some specimens of native iridium, that the metal whether in this state or pure as obtained by chemical skill and consolidated by fusion, must be allowed that preëminence in density which, until of late, was given to platinum.

It may be proper to add that subsequently to the writing of the preceding narrative, receiving some large quantities of iridium and rhodium, from Johnson and Cocke, my experiments were successfully repeated on a larger scale, but without any result besides that of confirming the facts above stated.

## Art. XXXIV.—*On the Meteoric Iron of Texas and Lockport;* by Prof. B. Silliman, Jr., and T. S. Hunt.

Several notices of the Texas Iron will be found in the former series of this Journal.* It was at first said to be not nickeliferous, but Prof. Silliman soon proved this statement to be an error. We are indebted to the united cupidity and ignorance of those who procured this fine specimen of celestial matter, for its being made known to science. Two costly, armed, and well organized expeditions were sent out for it, and inconceivable difficulties were encountered in a wilderness among hostile savages, before they at last succeeded in bringing it nearly two thousand miles over land to the Mississippi, elated with the confident delusion that it was *platinum*. We have in our possession a large number of original manuscript documents, which collectively constitute a full history of the discovery and procuring of this specimen. Our limits do not permit their publication, nor is it necessary that even a full abstract of them should be given. A sufficient account of these papers will be found in vol. viii, p. 218, of this Journal.

After this mass was presented to the collection in Yale College by Mrs. Laura Gibbs—widow of Col. George Gibbs, so well known to all cultivators of mineralogy—a portion of the smaller end was sawn off with much difficulty, which when reduced to a smooth surface, gave a brilliantly polished face about eight inches in diameter, on which is engraved an inscription commemorative of Col. Gibbs and the donor, and the weight of the mass—1635 *pounds*. This section revealed in a very perfect manner the crystalline structure of the mass, by the broad octahedral cleavages which appeared at one or two points where a fracture was made. By a planing machine, the surface of the

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* 1. "*Notice of the Malleable Iron of Texas*," viii, 218, (1824.) This notice contains a historical account of the discovery and of the expeditions of Glass and John Maley to obtain the mass now in the Yale College mineralogical collection.

2. "Analysis of the meteoric iron of Louisiana," by C. U. Shepard, xvi, 217, 1829.

3. A notice of the presentation of this mass to Yale College by Mrs. Gibbs, xxvii, 382.

4. Some further facts concerning the locality and other masses of metallic iron in Texas, xxxiii, 257.

portion which was removed was rendered quite smooth and level, and after being well polished, it was washed with dilute nitric acid. The lines of crystallization at once made their appearance in the most beautiful manner. The action of the acid was continued until the lines were etched boldly enough, to take ink and give an impression. The mass was so imbedded in type metal as to be capable of passing the copper plate press, and the impressions were then taken, of which the accompanying plate is one. This mode of proceeding, causes the iron to record its own crystalline character in the most faithful manner. This crystalline structure of meteoric iron is found in *most* but not in *all* the specimens of such iron which have been examined. Those who have seen the work of Schreibers* will remember the beautiful structure of the Agram iron, and many others, developed by acids. The Alabama meteoric iron† has however no distinct crystalline structure. The Columbia, South America, has very little; and the supposed meteoric iron from Oswego,‡ or Scriba, in New York, has none.

The Texas mass is a magnet; its greater diameter is nearly in the magnetic meridian, as it is now placed, and in this situation it possesses true polarity. One of the artizans employed in finishing up the polished face, noticed that the filings of the iron arranged themselves on the face in lines parallel to the crystalline planes, as if influenced by magnetic attraction. No large masses of pyrites were observed in this mass, though so abundant in the Lockport iron. This mineral is however not entirely wanting in the Texas iron, as is shown by chemical examination; and one or two small lumps of pyrites were encountered by the saw, in cutting the section before mentioned.

*Chlorine.*—Very soon after the section was made, both of its opposite faces were observed to be bedewed with moisture. This was washed off with distilled water and the washings tested for chlorine by nitrate of silver, with abundant evidence of the presence of this element. This exudation soon ceased, and the chippings of the iron examined by solution in pure nitric acid, and testing with nitrate of silver, gave no further evidence of the presence of chlorine. We conclude therefore that this iron prob-

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* Der Meteoreisen. † This Jour., 1st. Ser., xxxiv, 332.
‡ This Jour., 1st Ser., xl, 366.

ably contains in its interior parts, a small portion of chlorine, which has escaped from its surface, and hence only the deep section of the mass, gave evidence of its presence.

The frequent chemical examinations, by able investigators, of meteoric masses, have shown that their mode of combination is frequently peculiar, but so far no new elements in addition to those before known, have rewarded the search. Although our ideas of the unity and simplicity of cosmical laws are thus enlarged, we are not yet warranted in the conclusion that the matter of meteors is in all respects the same as that of our earth. From the fact that almost yearly additions are made to our list of elements, in minerals brought from parts of the earth long known and seemingly well investigated; may we not hope that these celestial visitors may yet present us from the distant regions of space, with some element before unknown? Perhaps an obscure affirmative answer is given to this question, by a fact noticed in this paper as observed in the Texas iron. Thus far our search has been far too limited to authorize us in asserting from the *negative* evidence obtained, that new elements do not exist in meteors. The attention of chemists has been too generally confined to the detection of a few bodies, which are already recognized as ingredients of meteoric masses, and no substance has for a long time been added to that list.

We have spent some time in the examination of various meteoric irons and stones, and although we have little that is new to present, our researches have not been without interest as showing the great general similarity in composition, which characterizes this remarkable class of bodies. We present now only the results obtained on the Texas and Lockport irons.

### *Examination of the Texas Iron.*

When this iron is dissolved in hydrochloric acid (A) a very small amount of insoluble matter remains, being only about ·5 per centum. This residue is a black powder, (B) interspersed with some scales of a leaden gray and containing numerous brilliant metallic plates of a silvery whiteness. It is almost entirely magnetic iron, the brilliant scales being either metallic nickel or an alloy of iron with a large portion of nickel.

The hydrochloric solution (A) afforded no precipitate when treated with sulphuretted hydrogen; and the iron being thrown down from a portion of it by ammonia, the filtrate was examined in vain for cobalt, manganese and zinc.

The insoluble black powder (B), when digested in aqua regia, was partly dissolved, while another portion remained, consisting of flakes of graphite, or at least of a very incombustible carbon containing a little iron. Sulphuretted hydrogen passed through the solution gave a yellowish brown precipitate, which was dissolved by hydrosulphuret of ammonia (C), leaving only a trace of sulphuret of *copper*. The soluble portion (C) was precipitated by acetic acid, and its color appeared to be orange, but was somewhat obscured by free sulphur. The results obtained from its examination were anomalous and rather unsatisfactory. It fused with nitre and carbonate of soda, forming a mass which was soluble in water without residue, and whose solution nitric acid did not sensibly affect. Treated with nitrate of silver and a dilute solution of ammonia, with reference to the detection of arsenic acid, it gave a *white* precipitate in place of the *red-brown* of the arseniate of silver. A part of the solution was treated with acetate of lead, and the precipitate obtained, when reduced before the blowpipe, gave a globule of lead, which at a red heat evolved white inodorous fumes resembling antimony. A want of sufficient material prevented any further examination, and the question of its true nature is consequently yet unsettled. Antimonic acid is precipitated from its salts by any strong acid, which was not the reaction of the substance under examination. If not antimony, it is probably a new body hitherto unexamined, although such a conclusion requires further evidence to warrant its correctness.

The analysis of 100 parts of this residue (B) gave—

| | |
|---|---|
| Iron, . . . . . | 31·2 |
| Nickel, . . . . . | 42·8 |
| Phosphorus, . . . . . | 4· |
| Carbon, . . . . . | 5· |
| Antimony? and Copper, . . . . | 9·3 |
| | 92.3 |

The iron in (B) is doubtless in the state of magnetic oxyd, and as such would make up the deficiency in this analysis.

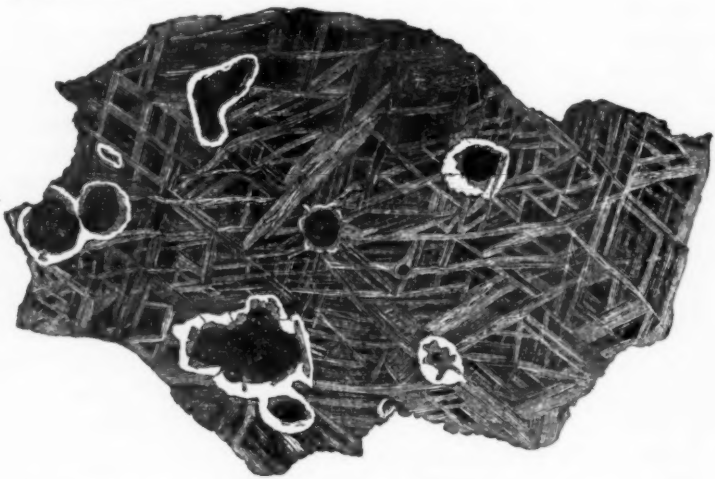
The proportion of nickel and iron in the Texas meteorite seems to vary. The mean of several analyses gives us—

| | |
|---|---|
| Iron, . . . . . | 90·911 |
| Nickel, . . . . . | 8·462 |
| Insoluble Phosphurets, &c. . . . . | 0·500 |
| | 99·873 |

The nickeliferous iron, or that part of the mass most rich in nickel, seems to have been segregated from the general mass, and forms the elevated lines of brilliant whiteness which appear on etching a polished surface of the metal.

### *Examination of the Lockport Iron.*

The history of this mass was given in this Journal, 1st Series, xlviii, 390, and also a preliminary analysis by the late D. Olmsted, Jr. For the sake of comparison, we again introduce the figure, showing its crystalline structure, and the white and yellow pyrites which it contains.



A quantity of this iron in small fragments was dissolved in hydrochloric acid, with the aid of a gentle heat; the solution was easily and rapidly effected, and the gas given off, being passed through a solution of acetate of lead, was found to con-

tain some sulphureted hydrogen, arising from the solution of the pyrites with which the mass is impregnated. A small insoluble residue remained in the solution, which was digested with a fresh portion of dilute acid without any effect. It was then collected and dried; it was partly light and flocculent, but the larger portion of it consisted of blackish gray scales, nearly all of which was attracted by the magnet. This insoluble residue makes up 1·4 per centum of the entire mass of the iron.

It dissolved in aqua regia, leaving a small amount of finely divided chestnut brown matter, so intimately suspended in the solution that it did not subside in twelve hours, but still gave a brown tint to the liquid. When ignited, it glowed for a moment and left a light reddish ash. It dissolved with effervescence in pure fused carbonate of soda and the mass treated with water, gave flocculi of silicic acid. These characters show the reddish brown matter to have been either silica with a trace of carbon, or silicon, which last Prof. Shepard has already shown to exist, in the Oswego iron.*

Hydrosulphuret of ammonium, threw down the metals from the solution in aqua regia, and the filtrate from this was found to contain phosphoric acid. The metallic sulphurets consisted solely of iron and nickel. A careful examination failed to detect either cobalt, manganese, or any other metal.

The original hydrochloric solution gave with sulphureted hydrogen, a small precipitate, of which a part was taken up by alkaline sulphurets and the residue consisted only of *copper*. The soluble part was too small to obtain from it definite reactions. It was probably arsenic.

One hundred parts of this insoluble residue gave—

| | |
|---|---|
| Iron, . . . . . | 44·1 |
| Nickel, . . . . . | 24·5 |
| Phosphorus, . . . . . | 11·4 |
| Silicon? . . . . . | 10·00 |
| | 90·00 |

The considerable deficiency in this result is probably due to the fact that the iron occurs in the compound, as magnetic oxyd, which is here estimated as metallic iron. The quantity of

* See this Journal, First Ser., vol. xl, p. 366.

phosphorus is very little more than is required to form a phosphuret with the nickel ($Ni_3P$), or with about half of the iron, and it is certainly difficult to conceive of the iron as retaining its magnetic condition, and resisting the action of hydrochloric acid, unless we suppose it to be in the state of magnetic oxyd.

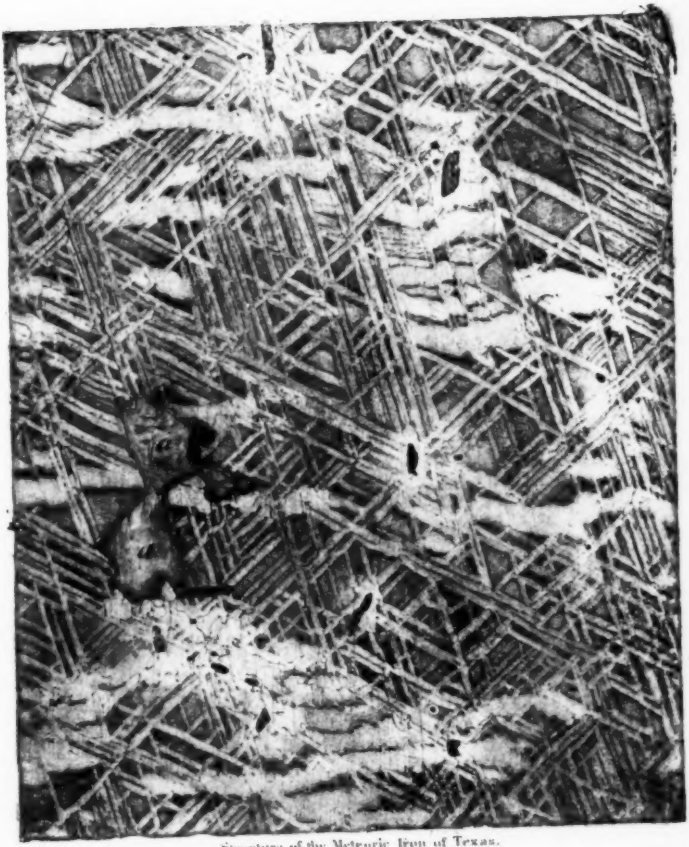
We may present the following as the constitution of the entire iron.

| | |
|---|---|
| Iron, | 92·583 |
| Nickel, | 5·708 |
| Copper, } Arsenic, } | Traces. |
| Insol. matter, | 1·4 |
| | 99·991 |

We have as yet no researches on the composition of the pyrites contained in these irons, which if we can obtain a sufficient quantity of the material, will be discussed on a future occasion.

It will be seen that we have not noticed the existence of cobalt in either of these masses, and as it has generally been spoken of, as a pretty constant ingredient in meteoric iron, it will be well to state the manner in which the examination for this metal was conducted. The iron was separated from the hydrochloric solution, previously peroxydized, either by an alkaline succinate, or as a basic salt by the process of Scherer; the metals still in solution were then precipitated as sulphurets. From the solution of these rendered ammoniacal, the nickel was thrown down by caustic potash, agreeably to the directions of Phillips, when hydrosulphuret of ammonium gave no precipitate in the filtrate, even after standing *one or two hours*. A similar mode of proceeding with both of the hydrochloric solutions, and those of the residue insoluble in that acid, gave the same results, and was supposed to prove the absence of cobalt. The oxyds of nickel and iron thus obtained, when examined by the blowpipe, gave no evidence of this metal.

Yale College Laboratory, July 27, 1846.



Structure of the Meteoric Iron of Texas.
Impression taken from the Iron.

ART. XXXV.—*Report on Meteorites.*—Read before the American Association of Geologists and Naturalists, at their meeting in New York, held September 2d, 1846; by CHARLES UPHAM SHEPARD, M. D., Professor of Chemistry in the Medical College of South Carolina and in Amherst College, Mass.

THIS report was undertaken with a view to collect all the information within reach, relative to the meteoric productions of the United States, (or at farthest those of North America.) In the prosecution of the work, however, I have been led to pay attention to meteorites generally; at least so far as to classify and describe the various mineral species they contain, to give a view of their chemical constitution, and to treat of some of those relations familiar to us as geological so far as these are common to meteor-masses.

## PART I.

### *Description of the Mineral Species found in Meteor-Masses.*

The number of species recognized in these bodies is *thirty-seven*. Their natural history properties readily permit them to be distributed into the three classes, and under thirteen of the orders of the mineralogical system of our earth. But as meteorites are now, by universal consent, admitted not to be of terrestrial origin, it would obviously be improper to describe the species of which they consist under the science of mineralogy, although we may perhaps be allowed to borrow temporarily the names of its orders; since, in the use proposed, no change in their significance is to be made. The natural history treatment of the meteoric species will therefore constitute a new science, for which the name ASTROLITHOLOGY is suggested, (from ἀστὶρ a meteor, λίθος a stone, and λογος a treatise.) The following is a tabular view of the systematic arrangement of the species.

### CLASS I.

*Order 1st, Gaseous.*

Sp. 1. Sulphurous Acid.

*Order 2d, Soluble.*

Sp. 2. Epsom-salt.
Sp. 3. Glauber's salt.
Sp. 4. Vitriolic Nickel.
Sp. 5. Copperas.

Sp. 6. Hyposulphite of soda, (nov. sp.)
Sp. 7. Hyposulphite of magnesia, (nov. sp.)
Sp. 8. Chloride of Iron.
Sp. 9. Chloride of Nickel.
Sp. 10. Chloride of Cobalt.
Sp. 11. Chloride of Calcium.
Sp. 12. Chloride of Magnesium.
Sp. 13. Chloride of Sodium.
Sp. 14. Soluble Silica, (nov.sp.)

CLASS II. *Order 1st, Haloide.*

Sp. 15. Apatite?
Sp. 16. Apatoid, (nov. sp.)
Sp. 17. Sphenomite, (nov. sp.)

*Order 2d, Ochre.*

Sp. 18. Dyslytite, (nov. sp.)

*Order 3d, Mica.*

Sp. 19. Mica.

*Order 4th, Spar.*

Sp. 20. Iodolite, (nov. sp.)
Sp. 21. Chladnite, (nov. sp.)
Sp. 22. Anorthite.
Sp. 23. Pyroxene.
Sp. 24. Chantonnite, (nov. sp.)

*Order 5th, Gem.*

Sp. 25. Peridot.
Sp. 26. Garnet.

*Order 6th, Ore.*

Sp. 27. Limonite.
Sp. 28. Chrome-ore.
Sp. 29. Magnetic Iron.

*Order 7th, Metal.*

Sp. 30. Native Iron, (nov. sp.)
Sp. 31. Nickeliferous Iron.
Sp. 32. Native Steel, (nov. sp.)
Sp. 33. Nickeliferous Steel, (nov. sp.)

*Order 8th, Pyrites.*

Sp. 34. Magnetic Iron-pyrites.

*Order 9th, Glance.*

Sp. 35. Schreibersite, (nov. sp.)

CLASS III. *Order 1st, Sulphur.*

Sp. 36. Sulphur.

*Order 2d, Graphite.*

Sp. 37. Plumbago.

*Descriptions of the species in the order of the foregoing arrangement.*—Such of the species as are common to mineralogy will be passed over with slight descriptions.

1. *Sulphurous Acid.*—This gas is freely evolved from a majority of meteoric stones, at the time of their descent. A fresh fracture or slight friction develops its odor, very perceptibly, in the Bishopville (S. C.) stone.

2. *Epsom Salt.*—This is dissolved out by water from the Alais stone, (Berzelius,) as also from that of Bishopville.

3. *Glauber's Salt.*—Dissolved out from the Bishopville stone.

4. *Vitriolic Nickel.*—Dissolved out from the Alais stone in small quantity, (Berzelius.)

5. *Copperas.*—Dissolved from pyritic masses of Cocke Co., Tenn. iron.

6. *Hyposulphite of Soda.*—Dissolved from the Bishopville stone.

7. *Hyposulphite of Magnesia.*—Dissolved from the Bishopville stone.

8. *Chloride of Iron.*—Dissolved from the Claiborne iron, (Jackson,) and from Asheville (N. C.) iron.

9. *Chloride of Nickel.*—Dissolved from the Claiborne iron, (Jackson.)

10. *Chloride of Cobalt.*—Contained in red rain which fell during half an hour at Blankenberg, Pays Bas., Nov. 2d, 1819, (MM. Meyer and Stoop.*)

11. *Chloride of Calcium.*—Dissolved out from the Bishopville stone.

12. *Chloride of Sodium.*—Found in the Stannern stone, (Scheerer.)†

13. *Chloride of Magnesium.*—Dissolved out from the Bishopville stone.

14. *Soluble Silica.*—Dissolved out from the Bishopville stone.

15. *Apatite?*—In small, yellowish-green, transparent grains, (H = 5·0,) found in the Richmond stone.

16. *Apatoid, (Shepard.)*—Thus named from its resemblance to apatite. It occurs in very minute quantity, in small, yellow,

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* Jour. de Phys., t. lxi, p. 469.

† Chladni, ueber Feuer-meteore, Wien 1819, p. 46.

semi-transparent grains in the Richmond stone, and still more sparingly in that of Bishopville. H.=5·5. It fuses partially before the blowpipe on charcoal, at the same time turning black. With borax it dissolves into a yellowish-brown glass. It does not contain phosphoric acid.

17. *Sphenomite*, (*Shepard.*)—Thus named from its resemblance to sphene. It occurs in brownish-grey (with a tinge of yellow,) thin, tabular crystals. H.=5·5. Implanted on crystals of black pyroxene, and associated with anorthite in the Juvenas stone. Before the blowpipe, it fuses readily into a black glass, which is magnetic. It dissolves in borax with effervescence, presenting the reaction of sphene. It is soluble in nitric acid, with the exception of a heavy white powder, insoluble in ammonia. The solution contained silicic acid and lime.

18. *Dyslytite*, (*Shepard.*)—Named from δυσλυτος, insoluble. It is a blackish-brown powder, which is brought to view by the action of acids, in the greater number of meteoric irons,—being present in them in proportions, varying from 0·25 to 2·25 p. c. It consists, according to Berzelius, of a phosphuret of iron, nickel, and magnesium.*

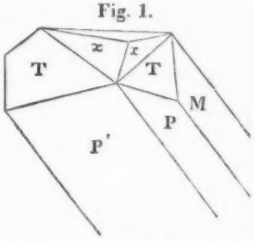
19. *Mica.*—Found, in a single instance, in small, brownish-grey, pearly, scales, attached to a mass of nickeliferous iron weighing 54 grs., from the meteoric stone of Weston.

20. *Iodolite*, (*Shepard.*)—Named from ωδης, violet-colored, on account of its violet color. Massive; in angular, somewhat rounded grains, (the largest $\frac{1}{8}$th of an inch in diameter.) Three sets of cleavages, whose relations to one another are not clearly to be made out. Color, pale smalt-blue. Lustre, vitreous: semi-transparent: brittle. H.=5·5 . . . 6·0. Before the blowpipe, it fuses easily and attended with ebullition, into a blebby, colorless glass, which while warm, retains a pale amethystine tinge. With borax, it dissolves slowly into a perfectly colorless and transparent globule. It does not act upon clean iron wire, when heated in powder with boric acid. In the state of powder, it was slightly acted upon by hydrochloric acid. Ammonia threw down silica from the solution, which however did not appear to retain either

* Whether the silicon I have found in this insoluble residue in the Asheville iron forms an ingredient in the present species, or belongs to an independent compound, I am unable at present to determine.

lime, or magnesia. It is found in small quantity, diffused through chladnite in the stone from Bishopville.

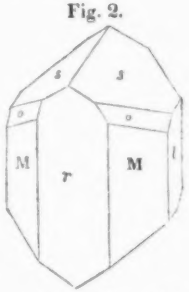
Fig. 1.




21. *Anorthite.*—In exceedingly minute, transparent crystals of the form here figured. P on M = 94.* Also massive, in the Juvenas stone.

22. *Chladnite, (Shepard.)*—This species is named in honor of Chladni, the scientific founder of this department of knowledge. It occurs in imperfect crystals, some of which are nearly an inch in diameter, whose primary form is a doubly oblique prism. Their general figure approaches very closely to that of some of the most usual forms of feldspar and albite. The natural faces are too rough to allow of measurement. By cleavage, which is effected with great facility, angles of 120° and 60° are readily obtained. Color snow-white, rarely with a tinge of grey. Lustre pearly to vitreous. Translucent, (in undecomposed fragments semi-transparent.) H. = 6·0...6·5. Very brittle. Masses half an inch in diameter are easily crushed between the fingers. Sp. gr. = 3·116. Alone before the blowpipe on charcoal, it fuses without difficulty and with phosphorescence, into a white enamel; with borax very slowly, into a transparent glass. It is a ter-silicate of magnesia. It forms more than two-thirds of the Bishopville stone.

Fig. 2.




23. *Pyroxene.*—This species is found in very distinct, black crystals in the Juvenas stone, having the form of the figure in the margin (Rose). It likewise occurs in large grained, greenish black, individuals in the Stannern stone, and of a pearl-grey color in that of Chassigny and many others. Fig. 2.

24. *Chantonnite (Shepard).*—Named from the Chantonnay stone, in which it is found, forming compact, black veins and angular shaped masses. Fracture subconchoidal. H. = 6·5...7·0. Sp. gr. = 3·48. Before the blowpipe, it melts on the edges into a dull, black slag.

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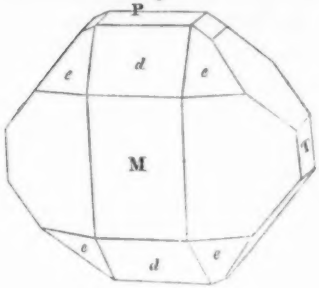
* Prof. G. Rose had observed twin-crystals of this mineral in the Juvenas stone, but he had suggested that they belonged to the species Labradorite. Ann. de Ch. et de Phys, Tom. xxxi, p. 81.

Fig. 3.

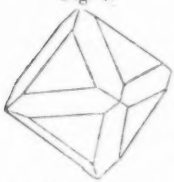



25. *Peridot.*—In very perfect crystals, (fig. 3, Rose), and in rounded, transparent grains in the iron of Krasnojarsk; also in irregularly shaped individuals of a pale, greenish yellow, or greyish white color, diffused through most of the meteoric stones.

26. *Garnet.*—In small, rich red grains, in no way distinguishable from the variety pyrope, either in hardness, color, fracture, or behavior before the blowpipe. In the Nobleboro stone.

27. *Limonite.*—In the form of iron-ochre upon the outside of the iron-masses, and of iron rust upon the fresh fracture of several of the stones.

Fig. 4.



28. *Chrome-ore.*—In crystals (fig. 4) in the Ensisheim stone, and in grains, in that of Chassigny. It likewise occurs in numerous meteoric irons.

29. *Magnetic Iron.*—Found massive in the seams and coatings in the iron of Scriba; also in the form of a black powder (mixed with dyslytite) as a residuum after the solution of certain irons in the acids.

30. *Native Iron.*—Massive. Sp. gr. = 7·26...7·5. Color iron-grey. Tough. Fracture hackley; subfibrous to granular. When etched, it exhibits on its polished surfaces, numerous shining, steel-like angular freckles, resembling the shining points which appear in certain nickeliferous irons, especially in the spaces between the raised silvery lines in the Burlington iron. Scriba, N. Y., and Walker Co., Ala.

The absence of nickel, chrome and cobalt in the Scriba iron, rendered its meteoric origin for a time doubtful; but the subsequent discovery of the Walker Co., Ala. mass, (weighing 165 pounds, and therefore too large to have been the product of the forge, and found in an unsettled region where iron-works never existed, moreover possessing the drop-shaped figure of several acknowledged meteor-masses,) can leave no doubt of its extra-terrestrial source.

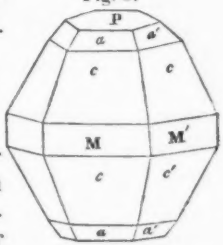
31. *Nickeliferous Iron.*—Under this name are probably included two or more species, which will hereafter be distinguished from each other. Sp. gr. = 6·5...8·0. Generally very crystalline, though sometimes nearly compact. When polished surfaces of this alloy are acted upon by dilute nitric acid, they generally afford very beautiful Widmannstättian figures; the precise arrangement of which is rarely identical, except in irons from one and the same fall.

32. *Native Steel.*—Massive. Highly crystalline: in laminæ generally parallel, sometimes confusedly crossing. H. = 6·0...6·5. Sp. gr. = 7·33...7·4. Color steel-grey. It yields very delicate crystalline lines on being etched. Randolph Co., N. C., and Bedford Co., Va.

33. *Nickeliferous Steel.*—In structure, it much resembles native steel. H. = 6·5. Sp. gr. = 7·117. Color steel-grey, inclined to pinchbeck-red. It contains (beside iron and carbon) nickel, copper and cobalt. Otsego Co., N. Y.

34. *Magnetic Iron Pyrites.*—Primary form, rhomboid. Secondary form, a modified six-sided prism. See fig. 5.

Fig. 5.




M on $c$ = 153° 30′.
$c$ on $a$ = 117 30.

Cleavage imperfect. Brittle. Lustre steel-like and splendent. Color steel-grey upon the crystalline faces; copper-yellow on fractured surfaces. Very liable to tarnish; of which, steel-blue and red form the most frequent tints. The crystals are generally hollow, or possessed of spherical cavities. Likewise massive and foliated. Sp. gr. = 4·454, (from Cocke Co., Tenn).

The crystals above described, occur lining cavities in the Richmond stone:* also, under a more highly modified form, in the Juvenas stone.†

35. *Schreibersite*, (*Shepard*).—Named in honor of the late Carl von Schreibers, Director of the Imperial Cabinet at Vienna, and a well known author on meteorites. In small, deeply striated prisms; angles indeterminate; traces of cleavage parallel with sides of prism. H. = 4·00. Lustre imperfectly metallic. Color brownish black. Streak unaltered. Opake. Brittle. Before the blow-

* See Amer. Jour, 1st Ser., xvi, 201.
† Ann. de Chim. et de Phys., t. xxxi, p. 87.

pipe, it emits sulphurous fumes; and flows without ebullition into a black glass, which is magnetic. With borax, it melts into a deeply yellow colored globule while hot, which on cooling becomes paler, and often shows a tinge of green. With tin, it forms a glass colored by chrome. The iron present, appears to be accidental, arising from the adhesion of magnetic iron pyrites; and the mineral will probably be found on complete analysis to be a sesqui-sulphuret of chromium. Found in small grains (the largest about the size of a rice-grain) in the Bishopville stone.

36. *Sulphur.*—This mineral occurs in small, semi-transparent grains and in powder, diffused through the Bishopville stone.

37. *Plumbago.*—Found in thin coatings between the layers of meteoric iron, and in little almond-shaped balls, dispersed through the same, in the Cocke Co., Tenn. iron.

As the whole number of well established mineral species belonging to mineralogy does not exceed three hundred and seventy, it will appear from the foregoing, that the meteoric species already recognized, equal one tenth those of our earth. The following table will show how far the meteoric species are common to the earth, and how far they are peculiar to the meteors.

| Meteoric species common to the earth. | Meteoric species peculiar to meteor-masses. |
|---|---|
| 1. Sulphurous acid. | 1. Vitriolic nickel. |
| 2. Epsom salt. | 2. Hyposulphite of soda. |
| 3. Glauber's salt. | 3. Hyposulphite of magnesia. |
| 4. Copperas. | 4. Chloride of iron. |
| 5. Chloride of magnesium. | 5. Chloride of nickel. |
| 6. Chloride of sodium. | 6. Chloride of cobalt. |
| 7. Chloride of calcium. | 7. Apatoid. |
| 8. Soluble silica. | 8. Sphenomite. |
| 9. Apatite ? | 9. Dyslytite. |
| 10. Mica. | 10. Iodolite. |
| 11. Anorthite. | 11. Chladnite. |
| 12. Pyroxene. | 12. Chantonnite. |
| 13. Peridot. | 13. Native iron. |
| 14. Garnet. | 14. Nickeliferous iron. |
| 15. Limonite. | 15. Native steel. |
| 16. Chrome-ore. | 16. Nickeliferous steel. |
| 17. Magnetic iron. | 17. Schreibersite. |
| 18. Magnetic iron pyrites. | |
| 19. Sulphur. | |
| 20. Plumbago. | |

The following is a list of seven of the most abundant of the meteoric species, (which are enumerated in the supposed order of their prevalence,) in the aggregate of meteor-masses at present known.

1. Nickeliferous iron.
2. Peridot.
3. Pyroxene.
4. Magnetic iron pyrites.
5. Anorthite.
6. Native iron.
7. Chladnite.

And of these, it is probable, that No. 1 constitutes $\frac{9}{10}$ths the weight of all known meteor-masses; while the seven species taken together, form $\frac{19}{20}$ths of such masses.

The four species out of these seven which are common to the earth, (peridot, pyroxene, magnetic iron pyrites, and anorthite,) form too insignificant a part of the crust of our globe to enable us to give, even a conjectural expression, in numbers, of their amount.

The contrast is therefore very marked between the mineral composition of the meteor-masses and of our earth. A species whose specific gravity is above 7, and which is metallic in its character, forms $\frac{9}{10}$ths of the former, while all the analogous species (i. e., those belonging to the order metal,) taken together, do not probably constitute $\frac{1}{1000}$th part of our globe! This remarkable discrepancy however will be much diminished, when allowance is made for the loss of all those meteoric stones which have fallen in early times, prior to the period in which mankind have begun to collect and preserve them. From the peculiar chemical composition of meteoric stones, it is plain, that unless collected soon after their fall, they would cease to be cognizable: whereas the iron-masses are capable of withstanding almost indefinitely, the action of the atmosphere and other destructive agencies to which they may be exposed after contact with our earth.

It is probable then that $\frac{99}{100}$ths, at least, of the meteor-masses known, fell in early times; some of it perhaps, anterior to the existence of man on the earth: and if we would form an idea of the correspondence between the metallic and the stony meteors of those times, we can only do so by comparing the ratio between the two during a fixed modern period, within which the masses of both kinds have been observed. Taking the last one hundred years with such a view, we find in the weight of the two iron-falls (Croatia, 1752, and Tennessee, 1835) as set off against that

of all the stones for the same length of time, a ratio approximating that of one (for irons) to twenty (for stones.)

The preponderance of the stony minerals in meteor-masses would also appear considerably greater, if we could correctly allow for the immense loss of matter which on the explosion of a meteor, must often accrue, in the pulverization of a body so weakly coherent as is the majority of the stones. The clouds from whence the showers of stones have so often been seen to issue, may be composed of the fine dust which has resulted from the complete rending of such bodies: while numerous accounts are on record, of the precipitation for hours together and over wide areas of country, of a fine impalpable powder, whose chemical composition has been found, in the general, to correspond with that of meteoric stones.

But after every allowance is made on the above mentioned grounds, it will still remain true that a prevailing metallic character and a high specific gravity, characterize the meteoric minerals when compared with those of our own planet.

## Part II.

### *Chemistry of Meteor-Masses.*

The chemical elements thus far known to exist in these bodies, are here arranged in the supposed order of their prevalence.

1. Iron.
2. Nickel.
3. Magnesium.
4. Oxygen.
5. Silicon.
6. Sulphur.
7. Calcium.
8. Aluminium.
9. Chromium.
10. Sodium.
11. Potassium.
12. Cobalt.
13. Carbon.
14. Phosphorus.
15. Chlorine.
16. Manganese.
17. Tin.
18. Copper.
19. Hydrogen.
?20. Titanium.
?21. Arsenic.

The above elements are among those most frequently found entering into the composition of the crust of our globe, (including also its atmosphere.) The individual parallelism in the two cases, may easily be seen from an inspection of the following table. It would be still more striking, if we knew how to make a just allowance for that portion of meteoric matter (the stony) which has fallen in early times, and from the nature of its

chemical constitution has either suffered, from atmospheric influences, a total decomposition, or at least become so much altered as no longer to be distinguishable. This arrangement of meteoric elements, like that given above, is constructed from a view of the totality of meteor-masses at present known to be in existence, on the surface of our globe. The terrestrial elements being arranged also as nearly as possible in the order of their abundance, the correspondence they sustain to the meteoric group, will at once be discerned by a reference to the numbers by which one and the same element is preceded on the two lists. The seven elements, among the twenty-eight terrestrial series, not yet detected in meteors, are followed each by a star.

| Meteoric Series. | Terrestrial Series. |
|---|---|
| 1. Fe. | 1. Ox. |
| 2. Ni. | 2. Si. |
| 3. Mg. | 3. Al. |
| 4. O. | 4. Ca. |
| 5. Si. | 5. Mg. |
| 6. S. | 6. Fe. |
| 7. Ca. | 7. K. |
| 8. Al. | 8. Na. |
| 9. Cr. | 9. S. |
| 10. Na. | 10. C. |
| 11. K. | 11. H. |
| 12. Co. | 12. Mn. |
| 13. C. | 13. Cl. |
| 14. P. | 14. F.* |
| 15. Cl. | 15. P. |
| 16. Mn. | 16. N.* |
| 17. Sn. | 17. Ba.* |
| 18. Cu. | 18. Zn.* |
| 19. H. | 19. Pb.* |
| ? 20. Ti. | 20. Cu. |
| ? 21. As. | 21. As. |
| | 22. Sr.* |
| | 23. Sb.* |
| | 24. Sn. |
| | 25. Cr. |
| | 26. Ti. |
| | 27. Ni. |
| | 28. Co. |

It is scarcely to be doubted but that fluorine will soon be detected in meteoric stones, inasmuch as it is a frequent constituent both of mica and of apatite; the former of which minerals, in very minute quantity, has been detected in the Weston stone, while the existence of apatite has been rendered highly probable, if not certain, in the Richmond meteorite. It is easy to conceive that several other terrestrial elements belong to the meteors, which from their volatility, may have been dissipated and lost in our atmosphere, before the masses to which they originally adhered could have reached the ground.

The manner in which the meteoric elements are associated is readily seen, by throwing the mineral species they give rise to, into four groups or orders.

ORDER FIRST.

1. Iron (Fe, *Native Iron*), and Iron-alloys ($Fe^{x}Ni$, *Nickeliferous Iron*).
2. Sulphur (S, *Sulphur*), and sulphurets ($Fe^{6}S^{7}$, *Magnetic Iron Pyrites:* $Cr^{2}{}^{1}S^{3}{}^{1}$ *Schreibersite*).
3. Carbon (C, *Plumbago*), and Carburets ($Fe^{x}C$, *Native Steel:* $Fe^{x}Ni^{x}C$. *Nickeliferous Steel*).
4. Phosphuret ($\overline{Fe\ Ni\ Mg}^{x}$ P, *Dyslytite*).

? 5. Silicet ($Fe^{x}Si$ ———).

ORDER SECOND.

1. Oxides ($Fe^{2}O^{3}+HO$, *Limonite:* $Fe^{3}O^{4}$, *Magnetic Iron:* $Cr^{2}O^{3}$, *Chrome-ore*).
2. Chlorides (Fe Cl: Ni Cl: Ca Cl: Mg Cl: Na Cl).

ORDER THIRD.

1. Oxygen acids ($SiO^{3}$, *Soluble Silica:* $SO^{2}$, *Sulphurous acid*).

ORDER FOURTH.

1. Sulphates ($MgO+SO^{3}$: $NaO+SO^{3}$: $NiO+SO^{3}$: $FeO+SO^{3}$).
2. Hyposulphites ($NaO+S^{2}O^{2}$: $MgO+S^{2}O^{2}$).
3. Silicates ($MgO+3SiO^{3}$ *Chladnite:* Silicates of magnesia, protox. iron, lime, alumina, soda and potassa, *Peridot*, *Pyroxene*, *Anorthite*, *Chantonnite*, and *Garnet*).

? 4. Titaniate (—— *Sphenomite*).

? 5. Phosphate (*Apatite?*)

The following is, to a short extent, a comparative table of the most abundant chemical compounds, among meteoric and terrestrial minerals.

Meteoric.

1. Iron alloys.
2. Silicates of magnesia, iron, lime, &c.
3. Sulphuret of iron.
4. Oxides of iron and chrome.
5. Chlorides of iron and nickel.

Terrestrial.

1. Silicic acid.
2. Silicates of alumina, potassa, soda and iron, (***Feldspar***, *Albite* and *Mica*.)
3. Silicates of alumina, lime, magnesia and iron, (*Hornblende*, *Pyroxene and Garnet*).
4. Water.
5. Carbonates of lime, magnesia and iron.
6. Sulphurets of iron.
7. Chlorides of sodium, magnesium and calcium.
8. Oxides of iron and manganese.

## Part III.

### *Astropetrology.*

Under this general head, the name of which is formed like that of the first department, (astrolithology,) with the exception of the two middle syllables, which are derived from the word πέτρος, a rock, instead of from λίθος, a stone,—the former having reference to an individual species, the latter to a rock-mass, it is intended to embrace information of the same general nature as that, which, in respect to our own planet, is contained under Geology. Astropetrology therefore, will very naturally have two departments of its own: viz. *Descriptive* and *Theoretical Astropetrology*.

### 1. *Descriptive Astropetrology.*

Under this head, the various rock-masses, or astropetrological species, will be enumerated and arranged. They will form two classes, each having three orders.

CLASS I. METALLIC.

| | | | |
|---|---|---|---|
| Order 1st, Malleable, homogeneous. | Sec. 1. Pure. - - - | | Scriba, N. Y.; Walker Co., Ala. |
| | Sec. 2. Alloyed. | Closely crystalline. | Green Co., Tenn.; Texas; Dickson Co., Tenn.; Burlington, N. Y. |
| | | Coarsely crystalline. | De Kalb Co., Tenn.; Asheville, N. C.; Guildford, N. C.; Carthage, Tenn. |
| Order 2d, Malleable, heterogeneous. | Sec. 1. Amygdalo-peridotic, | | Krasnojarsk, Siberia. |
| | Sec. 2. Amygdalo-pyritic, | | Lockport (Cambria), N. Y. |
| | Sec. 3. Pyrito-plumbaginous, | | Cocke Co., Tenn. |
| Order 3d, Brittle. | Sec. 1. Pure, - - - | | Bedford Co., Pa.; Randolph Co., N. C. |
| | Sec. 2. Alloyed, - - | | Otsego Co., N. Y. |

CLASS II. STONY.

| | | | |
|---|---|---|---|
| Order 1st, Trachytic. | Sec. 1. Peridotic, | Coarse grained, | Weston, Conn.; Richmond, Va. |
| | | Fine grained, | Nobleboro, Me.; Little Piney, Mo. |
| | Sec. 2. Pyroxenic, - - | | Juvenas, France. |
| | Sec. 3. Chladnitic, - - | | Bishopville, S. C. |
| | Sec. 4. Carbonaceous, - - | | ColdBokkeveld, Af. |
| Order 2d, Trappean. | Sec. 1. Homogeneous, - | | Chantonnay, France. |
| | Sec. 2. Porphyritic, - - | | Renazzo, Italy. |
| Order 3d, Pumice-like. | - - - - - - | | Waterville, Me. |

*Theoretical Astropetrology.*—The few facts known under this head, (i. e. which relate to the origin and formation of meteor-masses, the changes they have undergone from the various conditions in which they have been placed, and speculations regarding any traces of life they may contain,) have induced me to postpone any detail of them, to a fuller report on this branch of knowledge, which I hope to submit to the Association at a future period.

PART IV. *Summary of American Meteor-masses.*

CLASS I.

*Order* 1*st.* Section 1st.

1. Scriba, (Oswego,) N. Y. Found 1834. Described 1841. SHEPARD. Weight 8 lbs.

2. Walker Co., Ala. Found 1832. Described 1845. TROOST. Weight 165 lbs.

Section 2d. *Closely Crystalline.*

3. Green Co., Tenn. Found 1842. Described 1845. TROOST. Weight 20 lbs.

4. Claiborne, Ala. Found 1834. Described 1838. JACKSON. Weight about 40 lbs.

5. Livingston Co., Ky. Described 1846. TROOST.

6. Dickson Co., Tenn. Fell July or August, 1835. Described 1845. TROOST. Weight 9 lbs.

7. Texas, (Red River.) Found 1808. Described by GIBBS and SILLIMAN, Sen. Weight 1700 lbs.

8. Burlington, N. Y. Found 1819. Described 1844. SILLIMAN, Jr. Weight about 150 lbs.

*Coarsely Crystalline.*

9. DeKalb Co., Tenn. Described 1845. TROOST. Weight 36 lbs.

10. Asheville, N. C. Described 1839. SHEPARD. Weight about 30 lbs.

11. Guilford, N. C. Found 1820. Described 1841. SHEPARD. Weight 28 lbs.

12. Carthage, Tenn. Described 1846. TROOST. Weight 280 lbs.

13. Jackson Co., Tenn. Described 1846. TROOST.

*Order 2d.* Section 2d.

14. Lockport, (Cambria,) N. Y. Found 1818. Described 1845. SILLIMAN, Jr. Weight 36 lbs.

Section 3d.

15. Cocke Co., Tenn. Described 1840. TROOST. Weight about 2000 lbs.

*Order 3d.* Section 1st.

16. Randolph Co., N. C. Found 1822. Described 1846. SHEPARD. Weight about 2 lbs.

17. Bedford Co., Pa. Found 1828. Described 1846. SHEPARD. Weight a few ounces.

Section 2d.

18. Otsego Co., N. Y. Found 1845. Described 1846. SHEPARD. Weight 276 grs.

APPENDIX TO CLASS I.

19. Buncombe Co., N. C. Found 1845. Described 1846. SHEPARD. Weight 27 lbs.

20. Grayson Co., Va. J. B. ROGERS.

21. Roanoake Co., Va. W. B. ROGERS.

22. White Mountains, (near Franconia,) N. H. Described 1846. SHEPARD. Weight about 20 lbs.

CLASS II. *Order 1st.* Section 1st.

*Coarse Grained.*

1. Weston, Conn. Fell Dec. 14, 1807. Described by SILLIMAN, Sen., and KINGSLEY. Weight about 300 lbs.

2. Richmond, Va. Fell June 4, 1828. Described by SHEPARD. Weight 4 lbs.

*Fine Grained.*

3. Nobleboro, Me. Fell Aug. 7, 1823. Described by CLEAVELAND and WEBSTER. Weight about 5 lbs.

4. Nanjemoy, Md. Fell Feb. 10, 1825. Described by CARVER and CHILTON. Weight 16 lbs.

5. Sumner Co., Tenn. Fell May 9, 1827. Described by SEYBERT. Weight 11 lbs.

6. Forsyth, Ga. Fell May 8, 1829. Described by SILLIMAN, Sen., and SHEPARD. Weight about 36 lbs.

7. Little Piney, Mo. Fell Feb. 13, 1839. Described by HERRICK and SHEPARD. Weight about 50 lbs.

Section 2d.

8. Bishopville, S. C. Fell March, 1843. Described by SHEPARD. Weight 13 lbs.

*Order 3d.*

9. Waterville, Me. Fell Sept., 1826. Described by SHEPARD. Weight about 3 ounces.

APPENDIX TO CLASS II.

10. At Sea, lat. 30° 58′ N., lon. 70° 25′ W. Fell June 20, 1809. Described by GATEWOOD. Weight 6 ounces.

11. Caswell Co., N. C. Fell Jan. 7, 1810. Described by MADISON. Weight 3 lbs.

The descriptions of the foregoing American localities, so far as they have not heretofore been published, will conclude the present report; and will appear in the next number of this Journal.

ART. XXXVI.—*Catalogue of Shells Inhabiting Tampa Bay and other parts of the Florida Coast;* by T. A. CONRAD.

*Bivalves.*

*Amphidesma variegata*, Lam.; rare. Mullet Key of Tampa Bay.—*A. radiata*, Say; found alive on Mullet Key.—*A. orbiculata*, Say; rare. Mullet Key.—*A. equalis*,* Say; common. Mullet Key.

*Arca zebra*, dredged up alive in Tampa Bay.

*Artemis elegans*,* Conrad; rare. Mullet Key.—*A. concentrica*, Lam.; common. This and the preceding species have probably been regarded as identical, but in every stage of growth there is a uniform and marked difference; the former species being more orbicular and convex, and having much more remote and distinct grooves, a character as obvious on the young shells as on the adults. It is much the rarest of the two species, and occurs fossil in the Miocene of North Carolina.

*Anomia ephippium*,* Lin.; common. Keys of Tampa Bay.

*Arca scapha?* common. Mullet Key.—*A. incongrua*, Say; rare. Mullet Key.—*A. ponderosa*, Say; rare. Mullet Key.

*Avicula* ——; rare. Egmont Key, Tampa Bay.

*Astarte lunulata*,* Con.; common. Egmont Key, Tampa Bay. —*A. flabella;* rare. Egmont Key, Tampa Bay.

*Cardium citrinum*, Wood; common. Mullet Key.—*C. isocardia*, Lam.; common. Mullet Key.—*C. magnum*, Born.; common. Mullet Key.—*C. bullatum*, Lam.; rare. Mullet Key. —*C. Mortoni*, Con. Very abundant on the shores of Tampa Bay, and I do not remember finding it on any of the Keys. The allied species, *C. citrinum*, on the contrary, occurs only on the Keys. The former is readily distinguished by its far less size, want of polish, and the almost invariable purple spots which mark the interior of *C. Mortoni*. The latter lives as far north as Massachusetts, but the *citrinum* is confined to the southern coast.

*Carditamera floridana*, Con. Common in Tampa Bay frequenting oyster beds, (*Cypricardia nodulosa*, Mighels.) I did not find it on the Keys of Tampa. It also occurs on the shores of Key West and of Lignum Vitæ Key, East Florida. There are several Miocene species of this genus in Virginia, Maryland,

and North Carolina. It is very distinct from either *Cardita* or *Cypricardia.*

*Cardita tridentata,** Say; rare. Egmont Key.

*Chama arcinella,** Lam.; abundant on north end of Mullet Key.

*Cytherea gigantea*, Lam. Abundant. Mullet Key.—*C. maculata*, Lam.; rare. Mullet Key.

*Corbula limatula*, Con. Deep water, between Tampa Bay and Pensacola.

*Cyrena carolinensis*, Bosc. Head of Tampa Bay.—*C. Floridana*, Con. Common on the bay shores. It prefers salt water, whilst the former species invariably confines itself to the scarcely saline estuaries of rivers.

*Donax variabilis*, Say. The most abundant of all the bivalves of Florida, burrowing in the sand. As the surf rolls over them they come to the surface, burying themselves instantly as the waves recede.—*D.* ——. A small ovate species. Coast of Florida near St. Joseph's Bay.—*D.* ——. Longer than *D. variabilis*, with an arched base. Egmont Bay.

*Lucina nassula*, Con. Egmont Key. Nearly allied to the Miocene *L. cribraria*, Say.—*L. pennsylvanica*, Lam.; rare. Mullet Key.—*L. squamosa,** Lam.; rare. Mullet Key.—*L. tigrina*, Lam.; rare. Mullet Key.—*L. floridana*, Con.; very abundant. Mullet Key and bay shores. This is the analogue of the Miocene *L. anodonta*, Say. It is never so thick and variable in form nor so large as many of the fossil species.—*L. edentula*, Lam.; rare. Mullet Key.—*L. trisulcata*, Con.; rare. Egmont Key.

*Mactra ovalis?* Common. Egmont and Mullet Keys.—*M. lateralis,** Say. Abundant. Egmont Key.—*M. fragilis*, Lam. Common. Bay Shores.

*Modiola demissa*, Dill. Abundant. Bay shores.—*M. lateralis*, Say. Bay shores.—*M. papyria*, Con. Bay shores.—*M. americana*, (*M. tulipa*, Lam.) St. Joseph's Bay.

*Mytilus hamatus*, Say. Common. Manatee river, Tampa.—*M. cubitus*, Say. Common. Manatee river, Tampa.

*Meleagrina* ——. Rare. Egmont Key. A small species with profoundly elongated scales.

*Nucula acuta,** Con. Dredged up in deep water in the Gulf of Mexico.—*N. eborea*, Con. Rare. Egmont Key.

*Ostrea virginiana*, Gmel. Abundant in Tampa Bay.

*Osteodesma hyalina*, Con. Abundant in Tampa Bay and lives as far north as Massachusetts.

*Periploma inequivalvis*, Lam. Rare. Bay shores.

*Pecten concentricus*, Say. Common. Bay shores.—*P. dislocatus*, Say. Common. Mullet Key.

*Pinna* ——. Common. Mullet Key and Tampa Bay. It has distant series of long, thick, remote, tubular spines. I cannot refer to any of the descriptions or figures I have seen.—*P. floridana*, Con. Mullet Key. Rarely entire.

*Plicatula ramosa*, Lam. Common. Egmont Key.

*Solen ensis*, Lin. This is the variety *minor* which lives as far north as the Carolinas. The *major* is limited to the coast north of this latitude. This fact has led me to believe that two species are designated by the name of *ensis*.

*Solecurtus fragilis*, Van. Common. Egmont Bay. I think this species is distinct from *S. fragilis*, but in deference to the opinion of an eminent conchologist I have classed it as a variety of that species.

*Tellina punicea*, Lin. Mullet Key.—*T. acuta*, Wood. Rare. Mullet Key.—*T. lateralis*, Say. Common. Bay shores. This shell also inhabits St. John's river, East Florida, and is said to inhabit Africa and California.—*T.* ——. A thin sub-triangular species very common in Tampa Bay.—*T.* ——. Two or three undetermined species. Key shores.

*Venus cancellata*, Lam. Next to *Donax variabilis* the most abundant shell on Mullet Key.—*V. punctulata*, Valen. Egmont Key.—*V. Mortoni*, Con. Abundant in Tampa Bay, a gigantic species found also in Charleston harbor. The young shell is covered with elevated laminæ and generally has angulated markings, resembling those of *V. notata*. One specimen of considerable size has distinct distant broad fulvous radii. The species I believe never has a purple spot in the interior so general in specimens of *V. mercenaria*. The size is generally about six and a quarter inches in length and five and a half inches in height, and the weight of the shell without the animal about four pounds. It resembles the fossil *V. permagna*, Con., but that species has much more robust concentric lines or ridges, and attains a rather larger size.—*V. cuneimeris*, Con. Bay shores; common.

*Univalves.*

*Actæon floridanus*, Con. Bay shores.

*Bulla succinea*, Con. Common. Bay shores.—*B.* ——. Common. Mullet Key.

*Bullina canaliculata*, Say. Bay shores.

*Cancellaria cancellata*, Lam. Rare. Mullet Key.

*Cerithium protextum*, Con. St. Joseph's Bay.—*C. septemstriatum*, Say. Lignum Vitæ Key, E. Florida; Key West.—*C. eriense*, Kiener, (*C. nigrescens?* Minke.) Common in Manatee river. It is a singular error of Kiener's to give Lake Erie as the habitat of a species of *Cerithium*. It is found on the Atlantic Keys of Florida.—*C. dislocatum*, Say. St. Josephs Bay.—*C.* ——. Two undetermined species. Egmont Key.

*Crepidula fornicata*, Lam. Common. Mullet Key.—*C. maculosa*, Con. Common. Mullet Key.—*C. aculeata*, Lam. Common. Inhabits Oyster beds in Tampa Bay.—*C. unguiformis*, Lam., (*plana*, Say.) Key shores.

*Cypræa pediculus*, Very rare. Egmont Key.

*Cassis sulcosa*, Lam. Rare. Mullet Key.

*Columbella avara*, Say. Bay shores.—*C.* ——. Bay shores.

*Conus* ——. Bay shores.

*Dentalium eboreum*, Con. Southern coast of Florida.—*D. coarctatum*,* Lam., (*D. gadus*, Sow.) A single living specimen came up on the lead in deep water.

*Fulgur perversus*, Lam. Common. Bay shores.—*F. pyruloides*, Say. Common. Bay shores. The genus *Fulgur* of Montford is identical with *Pyrula*, Lam., and his priority by date of many years anterior to Lamarck's *An. sans Vert.*, though the name of *Pyrula* is generally adopted by conchologists. It would be useful to science, if some uniform rule were established with regard to certain authors, and either all Montford's genera rejected, or acknowledged where his names have priority in date of publication. *Pyrula ficus* and its congeners have been separated by Sowerby from the other members of the genus *Pyrula*, of Lamarck, retaining the name, whilst Rousseau has subsequently named it *Ficus*. The former would be preferable, as having long been in use, and not like the latter preoccupied in Botany, if *Fulgur* should be retained. If not retained, then the original name of *Pyrula* will revert to *P. canaliculata* and its congeners. Rous-

seau has described the animal of *Pyrula ficus*, and shown that it has more affinity for *Harpa* and *Dolium*, than for other species of Lamarck's genus *Pyrula*. In exterior characters and general appearance, the animal of Say's *P. papyracea* bears no resemblance to that of *Fulgur perversus* and its congeners. It is not operculated, and spreads a very singular mantle over nearly the whole shell. The mode of excluding their young in a spiral string of chambers is peculiar to the *P. perversa, pyruloides, carica* and *canaliculata*, which constitutes Montford's genus *Fulgur*.

*Fasciolaria trapezium*, Lam. Common. Bay shores.—*F. distans*, Lam. Common. Mullet Key and Bay shores.—*F. tulipa*, Lam. Common. Mullet Key and Bay shores.

*Fusus perrugatus*, Con. Manatee river. Fusiform, with remote longitudinal ribs, and large prominent revolving lines alternated with a fine line; whorls longitudinally rugose, upper half flat and oblique; aperture rather more than half the length of the shell, purple within; labrum striate; color of the exterior cinereous. Proportionally wider than *F. cinereus*, with fewer and larger ribs and lines.

*Fissurella*, ——. Key shores.

*Littorina littorea*, Say. Bay shores.—*L.* (*Phasianella*) *angulifera*, Lam. Abundant on grass, bushes and trees on the Bay shores.

*Murex ostrearum*, Con. Mullet Key.—*M. cellulosa*, Con. Inhabits oyster beds in Tampa Bay.—*M. tampaensis*, Con. Inhabits oyster beds in Tampa Bay.

*Marginella conoidalis*, Kiener. Abundant. Bay shores.—*M. succinea*, Con. Rare. Bay shores.—*M. albilabris*, Con. Rare. Bay shores.

*Monodonta*, ——. Tampa Bay. Common.

*Melampus bidentatus*, Say. Common. Bay shores.

*Melongena corona* (*Fusus*) Lam. Common. Bay shores. This shell has all the characters of the genus *Melongena*.

*Natica duplicata*?* Say. Mullet Key and Bay shores.—*N. canrena*,* Lam. Very rare. Egmont Key.

*Neretina* (*Theodoxus*) *reclinata*, Say. Manatee and Hillsborough rivers, Tampa; Mobile, Alabama.

*Oliva litterata*,* Lam. Common. Key shores, living a few inches deep in the sand, and readily found by its trail on the surface.—*O. mutica*, Lam. St. Joseph's Bay. Its habits are the

same with the preceding.—*O. anazores.* Southern coast of Florida.

*Ovulum aciculare*, Lam. Very rare. Tampa Bay.

*Patella*, ——.

*Pleurotoma*, a small black tuberculated species. Tampa Bay. —*P.* ——. Small; longitudinally ribbed; pale. Tampa Bay.

*Pollia tincta*, Con. Inhabits a sand bar at the entrance of Manatee river.—*P. cancellaria*, Con. Ship Island.

*Pyrula papyracea*, Say, (genus *Ficus*, Rousseau.) Mullet Key. Common.

*Pyramidella alveata*, Con. Rare. Bay shores.

*Pyrena scalariformis*, Say. Common. Inhabits pools on the Keys.

*Ranella caudata*, Say. Rare. Mullet Key.

*Strombus pugillus.* Common. Mullet Key.

*Scalaria*, ——. Rare. Bay shore.

*Triton lineolatum*, Con. Bay shores.—*Truncatella*, ——. Bay shores.

*Turbo castaneus.* Common. Mullet Key.

*Trochus tampaensis*, Con. Bay shores.

*Voluta Junonia.* Very rare. Egmont Key.

*Vermetus lumbricalis*, Lam. Mantee river.

### *Multivalves.*

*Balanus ovularis*, Lam.

*Coronula testudinalis*, Sow. On the green turtle in Tampa Bay.

*Pholas costata.* Rare. Mullet Key.

*Teredo navalis*, Lin. Common. Tampa Bay.

In the above catalogue the Miocene species are indicated by an asterisk.

Although the proportion of univalves and bivalves is nearly equal as to species, yet the bivalves far outnumber in quantity the former; and this is the case also in the Tertiary deposits. I had remarked this fact years ago, and alluded to it in my publication on the Miocene fossils. It holds good on every part of the coast I have visited, but in the bays, lagoons and estuaries I found the proportion of univalves much larger than on the sea beach.

The land shells about Tampa are *Polygyra plicata*, *P. septemvolva*, *Glandina truncata*, and a species of *Pupa*. On Lignum Vitæ Key, E. Florida, I found the same *Polygyræ*, with *Achatina fasciata* and *Succinea campestris*.

ART. XXXVII.—*Descriptions of new species of Organic Remains from the Upper Eocene Limestone of Tampa Bay;* by T. A. CONRAD.

BULIMUS.

*Bulimus floridanus.*—Ovate-acute, narrow; whorls 6? finely striated obliquely; spine elevated, longer than the aperture, whorls convex; body whorls with an impressed line which margins the suture; aperture narrow, subovate, labrum and labium reflected; base with a deep channel behind the reflected labium.

This is the only fossil land shell yet discovered in an American tertiary formation. Very few species of this genus exist in North America, and they are all limited to the southern portion of the Union. The B. floridanus is very dissimilar to any of these, being much less ventricose and having more affinity with the group constituting the genus Partula.

BULLA.

*Bulla petrosa.*—Oval, destitute of striæ? summit oblique.

Ballast Point, Tampa Bay. Rare.

NUMMULITES.

*Nummulites floridanus.*—Discoidal, diameter through the middle of moderate width; volutions about 3 in number; surface with minute revolving lines.

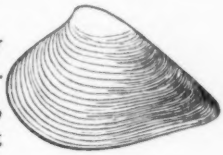
Occurs with the preceding. Abundant. It belongs to the subgenus Assilina, D'Orbigny.

*Cristellaria rotella.*—Discoidal, with impressed radii; middle of the anterior side with a sudden depression. Abundant. Occurs with the preceding.

This small fossil can be distinctly seen without a magnifier, and some specimens are large enough to shew the impressed lines. It closely resembles a species of the Paris Eocene. By breaking the rock into small fragments, specimens will fall out entire.

VENUS.

*Venus penita.*—Cuneiform, concentrically striated, the lines strong anteriorly, posteriorly less distinct, posterior side produced, compressed, extremity angulated; ligament



margin very oblique and straight from umbo to extremity; summits very prominent; cardinal teeth very robust; basal margin slightly arched posteriorly; inner margin crenulated.

Ballast Point, Tampa Bay.

Little of the shell remains, which exhibits those radiating furrows common to all the chalky specimens of the genus in a fossil state. A cast of the hinge shews the form of the teeth, and an impression in the rock copies the exterior characters of the shell.

*Venus floridana.*—Triangular, with concentric distant ribs; umbo broad, elevated; ligament margin very oblique, straight; valves slightly flattened or compressed posteriorly, extremity angulated.

Occurs with the preceding.

*Plagiostoma?*

An indeterminate species with numerous approximate somewhat squamose radiating undulated striæ.

Occurs with the preceding.

NUCULA.

*Nucula tellinula.*—Longitudinally ovate, with central beaks; anterior end narrow, slightly truncated at the extremity, anterior dorsal margin straight and very oblique.

Occurs with the preceding.

CYTHEREA.

*Cytherea floridana.*—Oval, inequilateral, rounded at the ends; ligament margin slightly curved; basal margin rounded.

Occurs with the preceding.

This seems to have been a smooth and polished species, but none of the shell remains.

BALANUS.

*Balanus humilis.*—Suboval, not elevated; aperture large, somewhat diamond shaped; valves with rather fine longitudinal approximate sulci.

Hillsborough Falls.

## SCIENTIFIC INTELLIGENCE.

### I. Chemistry.

1. *Atoms and Ray Vibrations.*—In the London and Edinburgh Philosophical Magazine for May, 1846, we find an article by Professor Faraday, entitled, "Thoughts on Ray Vibrations," in which, adopting Boscovich's idea of matter, (that it consists altogether of "forces,") he sets aside the old hypothesis of an Ether producing heat and light by its vibrations, and offers in its stead, the *forces*, of which the atom, or ultimate particle, is composed. He considers all effects of attraction and repulsion as happening in certain "lines of force," established between the atoms.

It is somewhat curious that so abstract an opinion should have originated almost simultaneously on both sides the Atlantic; for we find it distinctly announced by Mr. J. D. Whelpley, as a consequent of the same views of matter, in the number of this Journal for April, 1845,* a year previous to the publication of Professor Faraday's article. The same appeared also in a paper by the same gentleman, read before the American Association of Geologists and Naturalists, at New Haven, Conn., April, 1845.† In an abstract of this paper published in a pamphlet of the proceedings of that meeting, the existence of a light-producing ether is controverted, on the ground that the *forces* of the atoms of matter, (which compose it) are *substantially* extended through all space, and constitute thereby the true ether, whose vibrations are light and radiant heat?

Professor Faraday's argument is curious; and as this new hypothesis is like to excite much attention, we give the whole of it in a condensed form.

1. The question is, whether the vibrations of light may not occur in certain "lines of force," which "connect" particles and masses together. If we admit these "connections," there is no occasion for the hypothesis of an ether.

2. Matter should be regarded as composed not of dead particles, but of active centers of forces. These centers are mathematical points. The atoms are extensions of forces, from these points, throughout all space.

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* American Journal of Science and Arts, for April, 1845, xlviii, 352. Article on "The Idea of an Atom," by James D. Whelpley.

† See Report of the Proceedings, in which there is an abstract of the paper above mentioned.

3. All the atoms are "tied together," no matter how remote they be, by lines of mutual force, along which the vibrations proceed, and in which attractions operate.

4. The imaginary nuclei, or "little independent particles," of the old hypothesis are of no use in explaining gravitation, or any other of the more extended powers of matter; all the effects which we witness are due solely to the *forces*, and not to any *real* nuclei; we may therefore dismiss them as unnecessary, together with the æther.

5. "I do not perceive in any part of space any thing but forces, and the lines in which they are exerted."

6. "Mossoti has shown that gravitation, aggregation, electric force, and electro-chemical action, may all have one common connection, or origin; and so, in their actions at a distance, have they not in common that infinite scope which some of these actions are known to possess."

7. "In the view now set forth, the forces of the atomic centers are supposed to pervade (and make) all bodies and to penetrate all space."

8. The æther was supposed to do the same, but was divided by certain centers, from which it acted: These centers are now taken to be the same with those of the material atoms; and thus the æther vanishes.*

Mr. Whelpley begins his argument with the assumption, that the true idea of an atom *must* be attained by a simple induction from the properties of the mass, to the properties of the particle. That by this method alone can such an idea be attained. Thus, (1.) if every mass gravitates, every atom gravitates. (2.) If every mass is in electric relation to all other masses, every atom is in the same relation. (4.) If masses are elastic and expansible in change of temperature, atoms are the same. (4.) If masses become gaseous, it is the atom itself which suffers this increase of repulsion. (5.) If masses chemically combined interpenetrate and lose their proper characteristics, atoms do the same. (6.) If masses are always bipolar, or multipolar, in their relations to other masses, atoms are the same. (7.) Finally, if all the properties of a mass may be reduced to certain repulsions and attractions, acting from and about certain centers, (as it is certain they can), the atom itself *must* be conceived of, as composed in like manner of certain forces acting in the same manner.

The effect of this method of induction is to establish the idea of an atom upon natural and philosophical grounds. Thus, by the old axiom, "that a thing cannot act where it is not," which is a known condition

* Abstract of an article by Prof. Faraday, entitled, "Thoughts on Ray Vibrations." London, Edinburgh and Dublin Philosophical Magazine, and Journal of Science, for May, 1846, (page 345–50.)

of the *masses* of matter, we infer that the *atoms* also, cannot act where they are not; and that, in very truth, they are every where, (as Faraday assumes,) but diversely in different places. Thus, as the masses are gravitantly and electrically every where, excepting within certain small limits about their centers; so, *within these small limits*, they are present to each other in a different manner, namely, chemically, and mechanically.—The atoms being universally present in space through their electric and gravitant relation, they do really fill all space and constitute a true æther capable of propagating the motions of heat and light. *The small limits within and without which the powers operate, are the imaginary spheroidal limits of the 'nucleus' or lesser sphere of the atom.*

By this new atomic theory, the chemist unburthens himself of a great variety of hypotheses;—such as that of "*latent heat*," "specific heat,"* "visible dead molecules,"† "interstellary æther,"‡ "caloric," "electric fluids,"§ with all the hard drawn lines which separate the parts and powers of matter from each other, and prevent the conception of it as a whole.

It reduces every thing to *forces*. Reasoning from the always electrified and gravitant mass, to its least particle, it finds that particle in relation, through a line of gravity, (which is also a line of electric induction,) with every other least particle in the universe. The number of these lines being truly infinite, the whole of space is occupied by them. The substance in which they are generated is the ancient First Matter, or Potential, of which the human understanding forms an idea to itself, and calls it *matter*, or, (dynamically) *force*. This first matter always appears as *positive and negative*, resolving itself into oppo-

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* Proceedings of the sixth annual meeting of the Assoc. of Amer. Geol. and Nat., held in New Haven, Conn., April, 1845, (pages 17–22, of the pamphlet report.)

† Ibid., page 20.

‡ "If the central 'nucleus' contracts by *pulses*, or minute vibrations, these must be radiated from it in the manner of *waves;* traversing space, like the radiant *pulses* of light. But why are not these 'waves,' the same with those 'pulses?'—Assuming their identity, there would then be no place for an hypothesis of a peculiar æther of light and heat, since the atoms do of themselves constitute an æther;—for they pervade all space." *Idea of an Atom suggested by the phenomena of weight and temperature;* by James D. Whelpley, Amer. Jour. of Science for April, 1845.

§ Ibid p. 21. Every atom in the solid condition is regarded as having its *forces* P, N, resolved into crystallogenic axes ($p\ n, p'\ n', p''\ n''$,);—each of these is liable to a disturbance in the distribution of the forces $p$ and $n$; but by the universal law of equilibriums, if one is diminished the other is just as much increased; then add, that if $p$ in one atom is coincident with $n$ in another, they will always be exactly equal in intensity,—and it follows that the disturbance will propagate itself in the manner of electric pulses. (See also Amer. Jour. of Sci., April, 1845, xlviii, 364.)

sites. The theorist shows, that gravitation itself is a consequence of such a resolution: and that two atoms so composed will necessarily gravitate. (See Art. in this Journal for April, 1845, and Report of Assoc. of Americ. Geol. and Nat. for the same year.)

By this induction from the mass to the atom, the atom is made an Individual, having a specific *size*, which is the variable limit of its *molecular* force; and an *infinitude*, which is the extension of its gravitant and electric force:—It preserves this individuality, while it extends through, and interpenetrates with every other atom. It has also two kinds of polarity, the remote and the near; and also an antipolar, or unresolved state, when its two forces are coincident about the same center,—which is the gaseous condition. Liquidity is assumed to be an intermediate state between solid and aeriform; and solidity to be the state of ultimate polarity, when all its force is resolved, and divided into polar axes, ('crystallogenic axes of *Dana*.')

It will be seen, on a careful examination, that a theory of matter founded on such a method of induction admits of the exactest mathematical applications; and that it possesses a simplicity which adapts it alike to all phenomena.

Mr. Whelpley, in the following paragraph expresses definitely the views above alluded to and also others of equal importance with reference to the nature of heat. (Proceed. Assoc. of Americ. Geol. and Nat. 1845, p. 17.)

"When a body is heated it expands:—Hence,—*rise of temperature is the same with an expansion of the molecular spheres of the atoms.* If the motions of heat and light can be otherwise explained, the notion of an ether distinct from gravitant matter, may be set aside; but all the properties of a mass are reducible to *forces*, causing motion and rest: all the properties of an atom are, therefore, its forces, or powers. It follows that an atom can be known only by these forces; and because the *force* of gravity is every where present, in that sense, the gravitant atom is itself 'every where present:' and the same is true of its magnetic and electric force. *The extended atmosphere* of an atom is, therefore, its proper ether, through which it radiates pulses of heat and light, and is electrically, magnetically, and attractively, present in the whole of space.*

"Some substances, such as the metals, being more susceptible than others to change of temperature, the same is true of their atoms. The impenetrable nucleus, or molecule, of an atom, may be either greater or less. When a *cold* nucleus touches a *hot* one, the greater contracts, and the lesser expands; according to a law of *equilibrium of tempera-*

* Sanscrit, *atma*, breath, omnipresent power, first principle.

*ture;* which necessitates, *that a molecule, or repellent nucleus, shall be of equal temperature with those that are in contact with it.* And the reason of this law is axiomatic; for that all motion is attended with the loss or attainment of an equilibrium. *All forces of action and reaction, attraction and repulsion, develope each other, and are therefore equal.*

"When two nuclei, the same in kind, but differing in size, are brought in contact, they will presently divide the difference, both attaining the mean diameter, and the mean intensity of repulsion; for it is necessary to admit, *that the intensities of the spheres of temperatures vary inversely as the cubes of their diameters.* But if they be of different species, (e. g. gold and iron,) one will contract, or expand, more than the other. Thus, gold, under the same influences, contracts, or cools, more than iron; and this difference expresses what is inconveniently termed, their 'specific heat;' meaning their 'relative degrees of *in*susceptibility.' It would be more convenient to speak of their *susceptibility.*"

It is necessary to caution the chemist, against confounding the 'nuclei' of this theory, with the "hard particles" of the Epicurean, or Wollastonian, hypothesis: they are not 'hard, visible, particles,' but mere variable, invisible, *limits; in* which the repellent, and cohesive, forces are developed.

2. *On a simple method of protecting from Lightning, Buildings with Metallic Roofs;* by Prof. HENRY, (from Proceedings of American Phil. Soc., June 20, 1845.)—On the principle of electrical induction, houses thus covered are evidently more liable to be struck than those furnished either with shingle or tile. Fortunately, however, they admit of very simple means of perfect protection. It is evident, from well established principles of electrical action, that if the outside of a house were encased entirely in a coating of metal, the most violent discharge which might fall upon it from the clouds would pass silently to the earth without damaging the house, or endangering the inmates. It is also evident, that if the house be merely covered with a roof of metal, without projecting chimneys, and this roof were put in metallic connection with the ground, the building would be perfectly protected. To make a protection, therefore, of this kind, the Professor advises that the metallic roof be placed in connection with the ground by means of the tin or copper gutters which serve to lead the water from the roof to the earth. For this purpose, it is sufficient to solder to the lower end of the gutter a riband of sheet copper, two or three inches wide, surrounding it with charcoal, and continuing it out from the house until it terminates in moist ground. The upper ends of these gutters are generally soldered to the roof; but if they are not in metallic connection, the two should be joined by a slip of sheet copper. The only part of the house unprotected by this arrangement will be the chimneys; and in order to

secure these, it will only be necessary to erect a short rod against the chimney, soldered at its lower end to the metal of the roof, and extending fifteen or twenty inches above the top of the flue.

Considerable discussion in late years has taken place in reference to the transmission of electricity along a conductor; whether it passes through the whole capacity of the rod, or is principally confined to the surface. From a series of experiments presented to the American Philosophical Society, by Professor Henry, on this subject, it appears that the electrical discharge passes, or tends to pass, principally at the surface; and as an ordinary sized house is commonly furnished with from two to four perpendicular gutters (generally two in front and two in the rear,) the surface of these will be sufficient to conduct, silently, the most violent discharge which may fall from the clouds.

3. *Electric Conduction;* by C. G. Page, (in a letter to the Editors.)—Since my last communication on *Electric Conduction, &c.* published in your Journal for September, 1846, finding that the merit of original observation of the inductive action of atmospheric electricity upon extended conductors, has been by some attributed to me, I take early opportunity through your indulgence to correct any such impression. Your readers by a careful perusal of the paper, will perceive that I have introduced the subject, rather incidentally, to prove the sensitiveness of the galvanoscope used in the experiments, and that a sufficient disclaimer will be found in a concluding passage, as follows, viz: "During heavy storms a flash of lightning twenty miles distant from the wires of Morse's telegraph, will induce electricity in the wires sufficient to operate the magnets and work the telegraph, sometimes recording several signals," an occurrence which has been noticed occasionally, since the erection of the telegraph in the early part of 1844.

The merit of prior and original investigation with reference to these phenomena, belongs to Prof. Henry; the results of whose observations were published sometime since in the Transactions of the American Philosophical Society. The only novelty as far as induction is concerned in the observations made by myself, is that extraordinary kind of disturbance which the needle incurs, under which it will frequently move, not as if by sudden impulse, but rather gradually through an arc, sometimes of 10°, and there remain for sometime, and then return to what may be called its standard position, viz. that which is due *solely* to the influence of the galvanic current. It would appear that these changes are due not to *sudden* discharges of atmospheric electricity, but to the passage of clouds or masses of air in different electrical states over or near the building. The question then arises, does the roof of the building collect and transmit sufficient electricity to deflect the needle to this extent, or is it due to some other influence. It

has occurred to me that a charged cloud or stratum of air may by simple induction, without transference, so affect the conductors as to produce this disturbance. If so, a new field for investigation will be opened. At present, circumstances will not allow of any observations in the night, and pressing official duties forbid any thing more than casual observations during the day. I may mention in conclusion, that at present, the usual daily range of the galvanoscope is 20°, that is, from 8 A. M. to 6 P. M. At 8 A. M. the deflection is from 43° to 45°, and at 6 P. M. 23° to 25°.

4. *On the production of a new organic alkali;* by G. FOWNES, (Philosophical Transactions, 1845, 2d part, p. 263.)—When starch is distilled with diluted sulphuric acid, a small quantity of an oily matter passes over, accompanied by formic acid. This oil is obtained in larger quantity from bran; one pound of this, distilled with half a pound of sulphuric acid and three pounds of water, yielded a drachm of it. When pure, it is a colorless, oily fluid, which becomes brown by exposure to the air; it is slightly soluble in water, but easily in alcohol. Its odor resembles that of a mixture of oil of bitter almonds, and of cassia. Its sp. gr. is 1·168; boils at 323° F., and distills unaltered. Cold sulphuric acid dissolves it, giving a magnificent purple tint; nitric acid oxydizes it, forming oxalic acid.

Mr. Fownes has given to this substance the name of *furfurol*, (from *furfur*, bran,) and expresses its composition by the formula, $C_{15}H_6O_6$.

When placed in contact with five or six volumes of liquor ammoniæ, they slowly combine, and in few hours form a solid mass, which consists of a yellowish-white, flocculent crystalline matter, insoluble in water, but soluble in alcohol. Repeated analyses give for this substance the formula $C_{15}H_6NO_3$; it is formed from the oil by the addition of one equivalent of ammonia and the abstraction of three equivalents of water. This substance has all the properties of an *amide*. Acid decomposes it immediately, forming a salt of ammonia and setting free the oil. The same decomposition takes place slowly with water, the substance combining with the elements of the liquid, and regenerating ammonia and furfurol. The action of alkalies is however very peculiar. A boiling dilute solution of potash readily dissolves it without the evolution of ammonia, and on cooling, deposits brilliant silky needles of a new substance. This has precisely the same composition in a hundred parts as the amide from which it was derived, but differs from it entirely in its properties. It is a strong organic base, neutralizing acids, and forming definite crystallizable salts.

The analysis of its salts gives the formula $C_{30}H_{12}N_2O_6$, which is just double that of the amide. This substance is the only product of the reaction, the whole of the amide being obtained in the form of the

new alkaloid. It is soluble in boiling water, but crystallizes on cooling, and dissolves very readily in alcohol. These solutions have a strong alkaline reaction; their taste is slightly bitter, but that of the salts is powerfully so. Its combinations with acids are beautifully crystalline. The hydrochlorate forms fine acicular crystals resembling those of the corresponding morphine compound. Its formula is $C_{30}H_{12}N_2O_6$, Cl H+2HO. It is quite neutral in its reactions. With bichlorid of platinum it forms a sparingly soluble double salt, which is composed of one equiv. of each of its constituents. Mr. Fownes has described a large number of other salts of this new base, which he denominates *furfuroline*. He observes that they are precipitated neither by solutions of peroxyd of iron, oxyds of copper or silver, lime or baryta.

This substance is very remarkable in several particulars; the manner in which it is derived from an amide, is peculiar and interesting. Caustic alkalies generally decompose this class of compounds, evolving ammonia, but we see in this instance only a re-arrangement of its elements, producing a new and peculiar compound. Fownes has also shown that *hydrobenzamide*, a product of the action of ammonia on oil of bitter almonds, is slowly changed by the same process, into a new alkaloid which he has named *benzoline*. In this case the atomic weight remains unaltered. The statement relative to the behavior of the salts of *furfuroline* with those of other bases, is worthy of especial notice. That a hydrochlorate or sulphate, should not precipitate salts of silver or baryta, is an anomaly in the history of the alkaloids, and finds an analogy, only in the peculiar nature of the salts of ethyle and methyle, and the no less curious reactions of the analogous compounds of oxyd of chromium. The nature of the affinities which unite the elements in such compounds, presents a highly interesting subject for study and speculation.

The artificial formation of such compounds must be regarded as one of the greatest achievements of organic chemistry. The result of such discoveries does not however furnish us any key to the nature of the vital forces, but only demonstrates more clearly the fact that these compounds, although generated in organized structures, are the results of chemical, and not of vital action. All the products of organic life which the art of the chemist has as yet succeeded in artificially forming, are but the secreted or excreted products of the organism, and chemical affinities alone have produced them. These affinities are perhaps enabled to act with a peculiar power in the living structure, only so far as the organic forces may present the elements in such conditions as are peculiarly favorable to their action.

Many of the results which have rewarded the investigations of the organic chemist, are highly interesting and curious. Thus by the oxy-

dation of salicine, the bitter principle of the willow, we obtain a peculiar oil which is identical with the fragrant essence of the *Spirea ulmaria*. The oxydation of this oil has afforded us a new acid, the salicylic, which is very like benzoic acid in its properties, and may even be formed from it. In the decomposition of ligneous fibre by heat, a peculiar volatile liquid is generated, closely allied to alcohol in its relations, and containing, like that, the oxyd of a compound radical, which was named methyle, to denote its nature and origin. Both of these compounds were however regarded as merely results of the decomposition of native products. The late researches of Cahours and Gerhardt on the fragrant oil of wintergreen, *Gaultheria procumbens*, have shown us that it is a compound of this methylic oxyd, with salicylic acid. Thus we are able by a simple recomposition, to form the oil of wintergreen in any quantity. This is only one example of the beautiful results which have been unexpectedly developed in this department of science. These discoveries we may observe, have been principally the results of accident; the object of the investigator having been to decompose substances by various agents, and study the results of this decomposition. A more difficult, but more fruitful field of investigation, seems to be the application of the knowledge that we have derived from these experiments, to the artificial formation of certain determinate products. Already we have a large class of artificial alkaloids, and although it is not yet certain that we have formed one of those bodies which exists in nature, we have produced compounds closely allied to the natural ones in their properties. In *anilene*, which we are now able to form by a number of reactions from different bodies, we have an alkaloid, which closely resembles both in its chemical relations and in its effects on the animal economy, the alkaline principles of *tobacco* and *Conium maculatum*. It is worthy of remark also, that the composition of these bodies differs only in the proportions of carbon and hydrogen. We form anilene by a peculiar action, from benzole, a carbo-hydrogen, derived from benzoic acid; and if among the great number of compounds of these two elements which result from the decomposition of various organic substances, we can find the hydro-carbon which bears the same relations to nicotine that benzole does to aniline, we can at once form from that compound, the alkaloid. In the present state of chemical science, this seems by no means improbable, and we may yet be able to form morphine and quinine to such an extent as will render us quite independent of the present sources of these important remedies.

5. *On the relations of Oil of Mustard;* (Chem. Gazette, No. 61, p. 178, and No. 75, p. 495.)—The late researches of MM. Wertheim, Gerhardt and Will, have shown that the oil of mustard is the sulpho-cyanid of a new radical, which is capable of forming combinations with sulphur,

chlorine and oxygen. This, because its compounds are also found in the garlic (*Allium sativa*), he has named *allyle*. The oil of mustard (*Sinapis nigra*) does not exist ready formed in the seeds, but is generated when they are bruised and treated with water. A reaction between two bodies previously existing in the seed, gives origin to the oil. The transformation is analogous to that which occurs in similar circumstances in bitter almonds, and produces hydruret of benzoyle.

The new radical allyle is $C^6H^5$, (or All,) and the *oil of mustard* All Cy $S^2$. The *essential oil of garlic*, to which it owes its characteristic odor, is found to be a sulphuret of allyle, All S, and the *oil of assafetida* another sulphuret of the same radical. An oxyd of allyle has also been obtained. When oil of mustard is heated for some time to a temperature of 248° in contact with caustic soda and lime, the pungent odor of mustard entirely disappears, and we obtain in its stead a liquid which has a faint aromatic odor like that of leeks. This substance analysis shows to be oxyd of allyle All O. The soda is in part converted into sulpho-cyanid of sodium. The reaction is very simple, All Cy $S^2$+Na O=All O+Na Cy $S^2$. The oxyd of allyle appears to constitute the *volatile oil of leeks*, and also exists in the crude oil of garlic. It forms with nitrate of silver, a beautiful crystalline compound, which is Ag O. All O+N $O^5$.

The essential oil of garlic, as before mentioned, is a sulphuret of allyle, but in its crude state contains also the oxyd of allyle. It is easily formed from the oil of mustard. When we distill with a gentle heat a mixture of this with proto-sulphuret of potassium we obtain an oil which possesses none of the properties of the original, but evolves a powerful odor of garlic and is pure sulphuret of allyle. The reaction is similar to that affording the oxyd, All Cy $S^2$+K S=All S+K Cy $S^2$. The oil of garlic forms interesting double salts with chlorid of mercury and bichlorid of platinum. With a solution of the bichlorid of platinum, an alcoholic solution of the oil forms an orange-yellow crystalline precipitate, which is (Pt $Cl^2$, All Cl)+3(Pt $S^2$, All S). Sulphuret of ammonium decomposes the chlorids, and we obtain an insoluble compound, which is the double sulphuret of platinum and allyle (Pt $S^2$, All S.) Similar compounds are formed with mercury. The precipitate with an alcoholic solution of chlorid of mercury is 2(Hg Cl,) All Cl,+2(Hg S)All S. When this is distilled with sulpho-cyanid of potassium, a decomposition ensues by which we obtain *the oil of mustard*. The reaction is between the double chlorids, forming chlorid of potassium and sulpho-cyanids of mercury and allyle; at the same time the double sulphuret is decomposed into sulphuret of mercury and sulphuret of allyle, which last is found in the receiver mixed with the oil of mustard.

If we add the oil of garlic to an alcoholic solution of nitrate of silver, we first obtain sulphuret of silver, followed by a crystalline precipitate. If we dissolve this last by boiling, and filter the hot solution, we obtain on cooling, beautiful white prismatic crystals of the compound of nitrate of the oxyd of allyle and silver, AgO, AllO, N $O^5$. Ammonia decomposes this, and liberates pure oxyd of allyle.

When we distill oil of mustard with one of the higher sulphurets of potassium, we obtain a crystalline compound which is probably a higher sulphuret of allyle. It has a powerful odor of assafetida, and is probably identical with the sulphuret observed in the oil of that substance. The roots of *Alliaria officinalis* yield a volatile oil, identical with that of mustard. These results are interesting as developing a new and beautiful relation between a number of organic substances. They show the simplicity which nature exhibits in all her operations, deriving a number of complex and apparently distinct bodies from a single radical, by combinations which we are able to imitate in our laboratories. These discoveries are a beautiful illustration of the doctrine of compound radicals. Although we have not as yet been able to isolate allyle, yet we can form all its combinations, and transfer it from one union to another, so as to afford the most satisfactory evidence of its existence.

6. *On the Acid of the Bark of Viburnum opulus;* (Chem. Gazette, No. 77, p. 9.)—L. von Monroe has shown that this acid, which was supposed to be identical with that obtained from the fat of the dolphin and named *phocenic acid*, is really valerianic acid. This confirms the results originally obtained by Dumas.

7. *On the Artificial formation of Specular Iron;* by T. S. Hunt.—The following is perhaps worth recording, as it beautifully confirms Mitscherlich's theory of the formation of this oxyd in volcanic products. I precipitated a concentrated solution of perchloride of iron by caustic ammonia, threw the thick magma upon a filter where it was allowed to drain until it became solid. This was then partially dried at a gentle heat, when it cracked into small angular fragments. These consisted of hydrated peroxyd of iron mechanically mixed with a large quantity of chlorid of ammonium. On heating this in a platinum crucible, to 400° or 500°, the vapors of water and the ammoniacal salt were abundantly disengaged, and the mass became inflated and porous. The residue however was not pure oxyd of iron, for on heating it to bright redness, fumes of chlorid of iron were evolved, accompanied by hydrochloric acid, and an abundant deposit of dark red-brown oxyd of iron coated the side of the crucible. On cooling, the oxyd was found coated with a brilliant iridescence, which was still more beautifully seen in the small cavities disclosed on breaking the porous mass. A microscopic

examination showed this coating to consist of small scales of specular oxyd of iron, which exhibited all the splendid tints of the beautiful iridescent specimens from Elba.

The reaction which produced the specular iron, is possibly the following: A portion of the ammoniacal salt confined in the mass, which was half an inch in diameter, was unable to escape before the exterior became ignited. The heated oxyd reacted upon the chlorid of ammonium to form chlorid of iron and water. Both of these bodies can probably exist undecomposed when in contact with oxyd of iron, or at least the oxyd and hydrochloric acid if formed, would immediately react upon each other. But when they come to the suface the oxyd is deposited and the hydrochloric acid escapes.

8. *On the Compounds of Boracic Acid with Ether;* by MM. EBELMAN and BOUQUET, (An. Chem. et de Phys., May, 1846.)—Chloride of boron is prepared by passing dry chlorine over an ignited mixture of boracic acid and charcoal, and the product is conducted into a bottle of alcohol, by which it is readily absorbed. The alcohol is kept cooled, and after a time separates into two layers; the upper one contains the new product, and the lower hydrochloric acid and water. The ethereal liquid is purified by distillation, till a product is obtained which boils at 246° F. It is a limpid fluid of a fragrant odor and burning taste. Its specific gravity at 60° is ·8849. It dissolves readily in alcohol and is also soluble in water, but is almost immediately decomposed by it into boracic acid and alcohol. It is combustible and burns with a fine green flame evolving fumes of boracic acid. Analysis gives for its composition the formula $BO_3$, $3C_4H_5O$.

9. *Vitreous Boracic Ether.*—When the preceding compound is distilled from the original fluid, there remains in the retort a liquid, which on cooling forms a vitreous mass, having the odor of ordinary ether, but a very bitter taste. The composition appears to be $(BO_3)^2\ C_4H_5O$.

By a process similar to this, the authors have obtained compounds of boracic acid with the oxyds of methyle and amyle, which resemble in general character the borate of ethyle, and have a similar formula. One equivalent of boracic acid$=BO_3$ combines with 3 equivalents of the oxyds.

These compounds correspond to crystallized boracic acid $B_6O_3$, 3HO, while the vitreous ethyle compound is analogous to anhydrous borax $(BO_3)^2NaO$.

10. *Vitiated air in apartments*; (L'Institut, No. 654, July 15, 1846, p. 240.)—M. Lassaigne has shown by a series of investigations, that contrary to a common opinion, the air in a room which has served for respiration without being renewed, contains carbonic acid alike in every

part, above as well as below; the difference in proportion is but slight, and where appreciable, there is some reason to believe that the carbonic acid is in greater quantity in the upper parts of the room. These experiments establish the very important fact that all the air of a room must be changed in order to restore its purity. The plans sometimes resorted to, to draw off the air in the lower part of the room, or change this portion only by circulation, are wholly ineffectual as a means of ventilation.

11. *On the Products of the Oxydation of Gelatine by Chromic Acid;* by Prof. MARCHAND, (Chem. Gaz., No. 77, p. 10.)—40 grammes of gelatine were dissolved in a mixture of 1000 grammes of water and 300 of sulphuric acid, and the solution, after cooling, was mixed with 160 grammes of bichromate of potash. On heating the mixture the odors of the oil of bitter almonds and hydrocyanic acid are evolved. The distillate was agitated with oxyd of mercury, when a considerable quantity of cyanid of mercury and some formiate was obtained. The liquid distilled off from an excess of oxyd of mercury, still retained the odor of bitter almonds, which only disappeared after the addition of caustic potash and prolonged exposure to the air. From the solution a salt was obtained, soluble in alcohol, which gave with hydrochloric acid, crystals having all the characters of benzoic acid. These reactions leave no doubt that hydruret of benzoyle is a product of the oxydation of gelatine. When the gelatine is in excess we obtain nothing but carbonic with pure formic acid.

12. *Colors of Quartz;* by M. HEINTZ, (Poggend. Ann., l, 519.)—M. Heintz shows that the color of carnelian is not due to an organic substance; and that instead, it contains 0·05 per cent. of peroxyd of iron. He also states that the tint of amethyst is due to a compound of peroxyd of iron and soda, and not to manganese.

## II. MINERALOGY AND GEOLOGY.

1. *Stroganowite*, a new mineral; by M. HERMANN, (Journ. d'Erdmann, xxxiv, 177.)—This mineral was found in Russia, in the bed of the river Sludanka, in crystalline masses of a clear green color and foliated texture, cleaving also in two directions nearly at right angles. Specific gravity 2·79; hardness, that of apatite; lustre resinous; translucent or semi-transparent. It has the composition of scapolite, along with a portion of carbonate of lime, (a mixture ?) giving the formula $\dot{Ca}^2\ddot{Si} + 2\dot{Al}\,\ddot{Si} + \dot{Ca}\,\ddot{C}$.

2. *Xylite*, a new mineral; by M. HERMANN, (Journ. d'Erdmann, xxxiv, 177.)—Xylite is from the copper mines of the Ural. It is essentially a silicate of iron; it has a deep brown color, a fibrous fracture, specific

gravity 2·935; hardness inferior to calc spar. It is but slightly attacked by acids. It contains silica 44·06, peroxyd of iron 37·84, lime 6·58, magnesia 5·42, oxyd of copper 1.36, water 4·70=99·96.

3. *Antimoniate of Lead;* by M. HERMANN, (Journ. d'Erdmann, xxxiv, 177.)—This ore is from the district of Nertschinsk in Russia. It is amorphous, with a compact texture and resinous lustre; color generally sulphur yellow, sometimes grayish, green or black; specific gravity, 4·60—4·76. It consists of antimonic acid 31·71, oxyd of lead 61·83, water 6·46=$\dot{Pb}^3\ddot{S}b+4\dot{H}$.

4. *Native Titanium.*—It is reported by Mr. Rogers that native Titanium in cubes of a copper-red color has been found in the mines of Merthyr-Tydrill, in Cornwall, similar to those detected in the scoria of the furnaces at the same locality. It appears that in 1794, similar crystals were sent to Haüy, who considered them pyrites.

5. *Loxoclase;* by A. BREITHAUPT, (Phil. Mag., Aug., 1846, xxix, 150, from Poggend. Ann.)—Loxoclase is near feldspar in its characters, and comes from Hammond in the state of New York. It is distinguished by having an oblique cleavage parallel with the long diagonal though not always very distinct, and from this its name is derived. Hardness a little above ordinary feldspar; specific gravity 2·609—2·620; color yellowish gray, whitish and bluish gray. It has the general crystalline form of common feldspar, with the angle M : T=120° 15′. It fuses before the blowpipe with difficulty and shows in the outer flame an intense soda reaction. Composition, according to M. Plattner, silica 63·50, alumina 20·29, oxyd of iron 0·67, potash 3·03, soda 8·76, lime 3·22, water and fluorid of silicon 1·23. It occurs with pyroxene, graphite, and calc spar.

6. *Digenite and Cuproplumbite;* by M. BREITHAUPT, (Poggend. Ann., lxi, 671.)—These are two ores of copper from Chili. Digenite is a massive sulphuret of copper having a metallic lustre, a dark lead gray color, and giving a black streak. Hardness between 2·5 and 3·25 of Breithaupt's scale. Specific gravity 4·680. The same mineral has been found near Sangerhausen in Thuringia having the specific gravity 4·568. Composition; copper 70·20, silver 0·24, sulphur (loss) 29·56; formula, $\dot{C}u+4\dot{C}u$ nearly. Cuproplumbite has the cleavage of galena, a metallic lustre, black streak; specific gravity 6·42; fuses easily. Composition, sulphuret of copper 24·45; sulphuret of lead 74·98, sulphuret of silver 0.57=$\dot{C}u+2\dot{P}b$.

7. *Vanadate of Copper;* (L'Institut, No. 525, p. 68.)—This ore has been met with in the Ural, associated with sulphuret of copper, native copper, and malachite. It is in part pulverulent and also in reniform masses, consisting of folia of a citron yellow color and pearly lustre.

8. *Native Tin;* by M. HERMANN, (Jour. f. Prakt. Chem., xxxiii, 300.)—According to Hermann, native tin occurs in the gold washings of the Ural, in small gray metallic grains containing also some lead.

9. *Turgite;* by M. HERMANN, (Jour. f. Prakt. Chem., xxxiii, 96.)—Turgite is a hydrated peroxyd of iron from the Ural, of a brownish-red color, 3·54 to 3·74 specific gravity, consisting of peroxyd of iron 85·34, water 5·31, oxyd of lead and copper 1·85, gangue 7·50, formula $2\dddot{\mathbf{F}}e+\dot{\mathbf{H}}$.

10. *Bodenite;* (Poggend., lxii, 636; Berz. Jahresb., xxv, 1845, 365.)—Breithaupt has given the name *Bodenite*, derived from the locality, Boden in Saxony, to a mineral resembling orthite, containing cerium.

11. *Parisite*, a new cerium mineral; by M. BUNSEN, (Ann. der Chem. und Pharm., 1845, No. 2.)—Parisite was discovered by M. Paris in the valley of Musso, New Grenada. It occurs crystallized in bipyramidal dodecahedrons; the basal angles are 164° 58′, and the lateral of the pyramid 120° 34′. It cleaves easily, parallel to the base; hardness between fluor and apatite; specific gravity =4·350; color reddish brown; fracture vitreous and conchoidal; transparent in thin fragments. Heated it loses water and carbonic acid and becomes friable. It is infusible and phosphorescent before the blow-pipe. Composition, carbonic acid 23·51, protoxyd of cerium, lantanum and didymium 59·44, lime 3·17, fluorid of calcium 11·50, water 2·38=100·00.

12. *Saccharite;* by M. SCHMIDT, (L'Institut, No. 549, p. 227.)—Saccharite resembles somewhat a granular feldspar, and is from Silesia. It is either white, or greenish from a mixture with pimelite. Specific gravity 2·668. It is infusible before the blowpipe alone, and with great difficulty with soda. M. Schmidt obtained in his analysis, silica 58·93, alumina 23·50, peroxyd of iron 1·27, oxyd of nickel 0·39, lime 5·67, magnesia 0·56, potash, 0·05, soda 7·42, water 2·21. Excluding the water, it gives the formula $\dot{R}^3\ddot{S}i^2+3\ddot{\mathbf{R}}\ddot{S}i^2$, which is identical with that of leucite.

13. *Fischerite;* (Berz. Jahresb., xxv, 1845, 390.)—Fischerite is a phosphate of alumina ($\ddot{\mathbf{A}}l^6\dot{\mathbf{P}}^3$) containing, according to M. Hermann, 24 equiv. of water (24$\dot{\mathbf{H}}$). It comes from Nischne Tagilsk, in the Ural, where it occurs of a dull green color and translucent; specific gravity, 2·46. It is sometimes met with in transparent six-sided prisms.

14. *Turquois.*—M. Hermann finds that the blue Turquois has the formula $\ddot{\mathbf{A}}l^2\dot{\mathbf{P}}^3+4\ddot{\mathbf{A}}l+15\dot{\mathbf{H}}$.

15. *Keilhauite*, a new mineral; by A. ERDMANN, (Kongl. Vet. Akad. Handl., 1845.)—Keilhauite was found near Arendal, in Norway, in a feldspathic rock. It is massive, of a brownish-black color, and grayish-

brown powder; splinters are brownish red by transmitted light. It has one distinct and two indistinct cleavages, with the surface of the first vitreous in lustre and the others resinous. Hardness between quartz and feldspar. Sp. grav.=3·69. Before the blowpipe it fuses easily with some effervescence to a black shining slag. With borax it dissolves, taking an iron color, but after strong reduction becomes blood red. In a fine powder, it dissolves entirely in muriatic acid. Erdmann obtained in an analysis, silica 30·00, lime 18·92, peroxyd of iron 6·35, alumina 6·09, sesquoxyd of manganese 0·67, oxyd of cerium 0·32, titanic acid 29·01, yttria 9·62; from which he deduced the approximate formula $3\dot{C}a^3\ddot{S}i+\dot{\ddot{R}}\ddot{S}i+\dot{Y}\dot{T}i^3$. Scheerer (Poggend. Ann. lxiii, 459,) has named this mineral Yttro-titanite.

16. *Anatase, Brookite, and Rutile*, (Rammelsberg's Zweites Supplement; Jameson's Jour., xl, 383.)—Prof. Rose has shown (Poggend. Ann., lxi, 516,) that Anatase is pure titanic acid, like Brookite and Rutile. When exposed to heat, by which its specific gravity is not altered, or, to the action of solvents, it presents no phenomena different from those exhibited by the two minerals just mentioned, and the quantity of iron contained in it is still less than the amount in those two substances, (the Anatase of Brazil contains 0·25 per cent. oxide of iron.) Rutile, Brookite and Anatase, are the first decided example of a trimorphism, in whose members the titanic acid is distinguished by a different specific gravity. On being exposed to heat, however, the Anatase acquires the specific gravity of Brookite, and afterwards that of Rutile, and Brookite itself acquires the specific gravity of Rutile. It thus appears that, by the action of heat, the one substance is converted into the other; and precisely the same phenomena occur in the case of artificially prepared titanic acid.

17. *Kaliphite;* by M. Ivanoff, (Annuaire du Jour. des Mines de Russie, for 1841, St. Petersburg, 1844, p. 386; Berz. Jahresb., xxv, 1845, p. 331.)—Kaliphite is a Hungarian mineral, but the particular locality is not known. It forms a fragile, feathery mass, separating easily into acicular fibres; lustre resinous; opaque; powder reddish-brown; specific gravity, 2·81. Fuses easily on charcoal, before the blowpipe to a brown bead, gives an iron color with fluxes and becomes green with soda on platinum, affords much water and dissolves easily in muriatic acid. Composition, peroxyd of iron 28·80, binoxyd of manganese 28·13, water 19·01, silica 12·10, oxyd of zinc 6·30, lime 2·55, titanic acid 1·20, alumina 0·60, magnesia 0.70=99·39; formula, $2(\dot{Z}n,\dot{C}a)\ddot{S}i+3\dot{\ddot{F}}e\,\dot{H}^2+8+\ddot{M}n\,\dot{H}^2$.

18. *Amoibite;* (Jour. f. Pr. Chem. xxxiii, 402.)—This name is proposed by v. Kobell, for an ore of nickel, from Litchtenberg, in the Fichtelgebirge, which has the composition, nickel 37·34, iron 2·50, lead

0·82, cobalt, *a trace*, arsenic 45·34, sulphur 14·00=100; leading to the formula $Ni^2(As, S)^3$. It crystallizes in the tesseral system, and has the specific gravity 6·08. Heated in an open tube it affords arsenous acid, metallic arsenic, and sulphuret of arsenic. It fuses easily before the blowpipe, disengaging arsenical fumes. Nitric acid dissolves it, with a deposition of the sulphur.

19. *Margarodite.*—This name has been given by Schafhäutl, to the *schistose talc of Zillerthal*, a mineral allied to mica, and consisting of silica 47·05, alumina 34·90, peroxyd of iron 1·50, magnesia 1·95, potash 7·96, soda 4·07, water 1·45=98·88.

20. *Mowenite and Harmotome;* (L'Institut, No. 644.)—MM. Damour and Descloizeaux, suggest the propriety of uniting the mowenite of Thomson, with harmotome, both on crystallographic grounds and chemical composition. Mowenite afforded on analysis, silica 47·60, alumina 16·39, baryta 20·86, oxyd of iron 0·65, potash 0·81, soda 0·74, water 14·16=101·21.

21. *Brochantite and Krisuvigite;* (Poggend., Ann. lxii, 138; Berz. Jahresb., xxv, 1845, 395.)—M. Rammelsberg obtains for the formula of Brochantite $\dot{Cu}\ddot{S}+3Cu\dot{H}$, which is also that of the so-called Krisuvigite.

22. *Perowskite;* (Poggend. Ann., lxii, 596; Berz. Jahresb., xxv, 1845, 370.)—Perowskite has been analyzed in the laboratory of H. Rose, and found to be a titanate of lime, with the formula $\dot{Ca}\ddot{Ti}$.

23. *Phacolite;* (Poggend., lxii, 149; Berz. Jahresb., xxv, 1845, 363.)—The Phacolite of Leipa in Bohemia, has been analyzed by Rammelsberg, who obtained the formula $2\dot{R}\ddot{S}i+\ddot{A}l^2\ddot{S}i^3+10\dot{H}$; he remarks that the result agrees precisely with Connell's analysis of Levyne.

24. *Mica;* (Pogg. Ann., lxi, 377; Berz. Jahresb., xxv, 1845, 359.)—M. Lohmeyer, by an analysis in H. Rose's laboratory, obtained for the formula of a hexagonal lithia-mica, from Zinnwald, $KF+\ddot{R}^2\ddot{S}i^3$, a little soda and lithia being substituted for part of the potash.

A dark greenish-black mica from Vesuvius afforded M. Chodnew, silica 40·91, alumina 17·79, peroxyd of iron 11·02, magnesia 19·04, lime 0·30, potash 9·96, with no fluorine or chlorine; giving the formula $\dot{Mg}^3\ddot{S}i+\ddot{A}l\ddot{S}i$, some potash being included with the magnesia, and oxyd of iron with the alumina.

25. *Arragonite and Calc Spar*; (L'Institut, No. 654, July 15, 1846, p. 240.)—MM. Silberman and P. A. Favre have arrived at the conclusion that these two minerals are isomeric, and that the dimorphism of carbonate of lime is due to this principle. The arragonite is shown to be the higher of the isomeric compounds.

26. *Bucholzite of Chester, Pennsylvania;* (Berz. Jahresb., xxiv, 1844.)—Erdmann has determined the composition of this mineral as follows:—silica 40·08, alumina 58·88, protoxyd of manganese 0·74= 99·67, which approaches that of andalusite, and gives the same formula, $\dddot{A}l^4\dddot{S}i^3$.

27. *Sillimanite;* (Ofversigt af K. V. Ac. Förhandl., 1844, 91; Berz. Jahresb., xxv, for 1845, 348.)—M. Staaf, in Svanberg's laboratory has analyzed the Sillimanite of Pettypaug (Chester) near Saybrook in Connecticut, and found for its composition, silica 33·362, alumina 58·622, peroxyd of iron 2·174, magnesia 0·398, lime *a trace*, evaporated 0·428=98·984: which affords the formula of Kyanite, $A^3S^2$.

28. *Bismuth Silver;* (Ann. des Mines, 4 Ser., vi, 165.)—Domeyko gives for the composition of a bismuth silver from Copiapo, S. A., silver 60·1, bismuth 10.1, copper 7·8, arsenic 2·8, gangue 19·2. The silver compound, omitting the copper, &c., equals $Bi\,Ag^6$.

29. *Arsenical Antimony;* (Poggend. Ann., lxi, 137; Berz. Jahresb., xxv, 1845, 334.)—This ore from Allemont in Frankreich, has been analyzed by Rammelsberg, with the result, antimony 37·85, arsenic 62·15=$Sb\,As^3$.

30. *Staurotide;* by M. Jacobson, (Poggend. Ann., lxii, 419.)—The staurotide of St. Gothard has afforded M. Jacobson, under the direction of H. Rose, silica 29·72, alumina 54·72, peroxyd of iron 15·69, magnesia 1·85=101·98. Other analyses by him correspond nearly with the one here cited. The above gives the formula $\dddot{A}l^2\dddot{S}i$ or $A^2S$, the oxyd of iron, being included with the alumina.

31. *Scolezite and Natrolite;* (Poggend. Ann., lix, 368 and 373.)—An analysis of scolezite by Gülich gives for its composition, silica 46·76, alumina 26·22, lime 13·68, water 13·94, corresponding to the simple formula, $\dot{C}a\dddot{S}i+\dddot{A}l\,\dddot{S}i+3\dot{H}$.

Natrolite, according to analyses by Sander and Scheerer, affords the formula $\dot{N}a\dddot{S}i+\dddot{A}l\,\dddot{S}i+2\dot{H}$. One of Scheerer's analyses (of the var. Bergmannite) gave silica 48·12, alumina 26·96, lime 0·69, peroxyd of iron 0·22, soda 14·23, potash, *a trace*, water 10·48.

32. *On Iolite;* by W. Haidinger, (Pogg. Annal., 1846, lxvii, 441.)—In an elaborate memoir on the mineral Iolite, including its several varieties, M. Haidinger shows that the so-called mineral species, Pinite, Fahlunite, Weissite, Bonsdorffite or Hydrous Iolite, Gigantolite, Chlorophyllite, Praśolite, Esmarkite, and perhaps also Oosite,* are only

* M. Haidinger cites the suggestion made by Mr. Dana in his Mineralogy, (2d edit. p. 307,) that several of the above-enumerated minerals were derived from the alteration of Iolite.

pseudomorphs of Iolite, arising from a change of composition in crystals of this species. The change approximates the material to the mica or steatite family, altering the crystallization and rendering the structure foliated or micaceous, parallel to the base of the prisms.

33. *Gold at Dedham, Mass.;* by J. H. Blake, (communicated for this Journal.)—Recently, upon exposing to view a small portion of a vein of quartz in granite in the town of Dedham, I discovered numerous small particles of gold, some of them weighing from two tenths to eight tenths of a grain. The average width of this vein is about four inches; its course is E. 10° N. by W. 10° S., and its dip is to the southward at an angle of 76°.

Occurring in the same vein there is found also sulphuret, black oxide and carbonate of copper, together with galena containing silver. Another vein affording galena, about five feet south of this vein, and having a like direction and inclination, has been exposed.

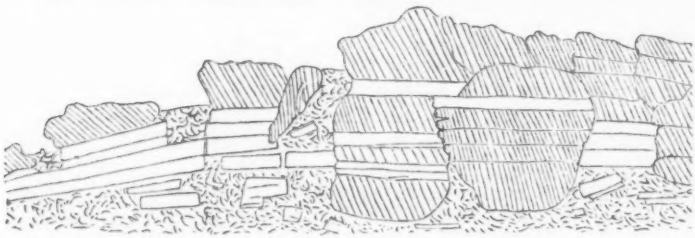
34. *Gold washings of the Rhine;* by M. Daubrée, (L'Institut, No. 654, July 15, 1846.)—Some centuries past, the gold washings of the Rhine were quite flourishing: but since the discovery of America, they have lost their importance, till now there are but few persons employed upon the banks of this river, and only about 45,000 francs of gold are annually extracted between Bâsle and Manheim. Explorations have been made above Constance; but the most productive region is within the limits just stated; and here both banks are equally productive. The working is considered as paying when a workman can collect one and a half francs per day. The sands of the first quality have a richness represented by 0·000000562; those of the second quality, by 0·000000163; the sterile sands, taken promiscuously furnished scarcely 0·000000008. The sands of Siberia are five times more rich, and those of Chili ten times more so, than the best of the Rhine. The auriferous land of the river is calculated to contain 52,000 kilogrammes of gold, having a value of 165,828,000 francs; but it is mostly covered by soil under culture.

35. *Observations upon some Sandstone Rocks in Baldwin Co., Ala.;* by Artemas Bigelow.—I perceive by Mr. Lyell's letter in the March number of this Journal, that he has recently been in Alabama; but he makes no mention of a sandstone formation, which is quite extensive in the southern part of that state. Mr. Buckley, in one of the former numbers of the Journal, mentions it as being near the rocks in which the Zeuglodon is found, and as containing tubes of sandstone. It is also exposed near Pensacola. In Baldwin Co. it is exposed frequently through an extent of several miles along the sloping ground which descends to the Tensaw River; which river divides from the Mobile on the east and unites again at the Bay. I have found the sandstone, also on the level land more than six miles from the river.

Baldwin Co. is a part of that alluvial region lying along the Atlantic Ocean and the Gulf of Mexico. It extends from the Gulf along the east side of Mobile Bay, Tensaw and Mobile rivers, about 100 miles, and is about 50 wide in its broadest part. Its general surface is nearly level, covered with a continuous forest of the long-leaved-pine, with the exception of here and there savannahs, which are wet and miry, producing tall rank grass. On the edge of one of these, a large quantity of clear water boils up with much force, through a bed of quicksand. There are also numerous small ponds. Wherever the recent action of water has worn away the earth for several feet, beds of clay are exposed. This surface is about 200 feet above the Tensaw River; at about two miles distant from the river, it begins to slope down to it, and is cut into deep ravines, from the sides of which and upon the sloping surface, the sandstone is exposed. First, nearly on the height of land, are found tubes like those mentioned by Mr. Buckley, with this difference, those contained yellow ochre, these contain fine or coarse sand varying in color from the purest white through the shades of yellow to almost a red; the sand is stratified, generally lengthwise the tubes, sometimes transversely. In some localities these tubes contain silicified wood; the wood is found, in small fragments, in great abundance. I have dug out tubes from four to six feet long. About 60 feet below these, three quarters of a mile distant, are three or four small masses of the sandstone jutting from the sloping surface, which contain abundant but very obscure impressions of shells, apparently all bivalves. There are evidently several genera; the outlines of some are quite regular, and in two or three a part of the hinge is discernible. Still lower 40 or 50 feet, a quarter of a mile distant, the sandstone is exposed several feet thick, but I could not find any organic remains. The impressions of shells contained yellow ochre.

At the highest point, where the tubes are found, there are several ledges of the sandstone, over which fragments are scattered, bearing N. E. and S. W., appearing to have been washed by currents of water from the north. The strata vary in thickness from one half an inch to two inches; are inclined at an angle of 15°, 25°, and 30°, according to the locality, generally about 30°; and dip to a point a little S. of E. as if deposited from the W. or N. W. They are very much fractured, the faults perpendicular, yet the sandstone appears to be in its original position. The evidence for this is the fact, that the tubes are nearly all found horizontal, which would be their proper position if formed around sunken wood, as I suppose they were. The strata are every where at an angle of about 30° to the tubes; these are imbedded in the sandstone; they are nearly as hard again as the strata, the proportion of iron being so great that they are of a very dark iron color. I exca-

vated to the depth of about six feet under one of the ledges, and found that the stone had entirely decomposed, leaving the tubes smooth and perfect, filled with variously colored sand. The fact that the sandstone, is so much decomposed under the surface, has led me to think that much of this sandy region in Alabama has been formed by the wearing away of this formation. The evidences tend to show that it extended over a large portion of South Alabama, but organic remains are discovered only in a few places. It is questionable whether impressions of shells can be found in any other place than the one I have mentioned, and there the extent of surface exposed is not a rod square.



The above is a section of the upper part of a ledge showing the relative position of the tubes and the strata, and an appearance of having been undermined at one end. Wherever I have seen the sandstone so as to mark the strata, they are about as above, except at the lowest place, mentioned as 40 feet below the strata containing shells, and 100 below the above ledge, where the angle of inclination is 15°. There is a ledge five miles distant from the above, where fragments of tubes are found, much more elevated, as high probably as any portion of the country. Another locality where I found silicified wood, in fragments, scattered abundantly over the ground, is nearly as high as the last mentioned ledge.

The tubes are generally round or oval, from one half inch to 12 inches in diameter of various lengths,—I saw one six or seven feet long, and six inches in diameter;—they are not always perfectly straight, but generally curved or a little crooked; the layers are concentric, and vary in thickness; the stone forming the tube is sometimes an inch thick. Where they are exposed to the air, they are hollow; beneath the surface they are filled with sand as before described.

One specimen of the tubes containing silicified wood is six inches long and oval as if it had been compressed, an inch and a half in the greater diameter; the rings are very distinct in the wood, and it was entirely surrounded with stone. Some specimens of the wood had undergone partial decomposition.

These tubes appear to have been formed around wood, that was brought down by a river, or rivers, perhaps through numerous mouths, and deposited: after the tubes were formed, the wood at greater depths seems to have decomposed and passed off, and its place filled with various colored sand; that more elevated in its position, petrified, leaving us evidences by which to know the origin of the tubes. The sandstone was forming during this process, being thrown down at an angle of about 30°, as before stated, and in the same direction with the tubes, as if both were deposited by the same current. The lowest strata contained no organic remains that I could discover; the middle were inhabited by several species of shells; the upper received deposits of drift-wood. The age of this sandstone I am unable to determine; I hope to have the opportunity soon of submitting my specimens to some one well acquainted with fossils.

The above facts are extracted from an article, read by me before the Nat. Hist. Soc. at the Wesleyan University, upon this subject, nearly five years ago.

36. *Fossil Forest in the Parkfield Colliery, near Wolverhampton.*—In a seam of coal, seventy three trees were counted by Mr. H. Beckett, scattered over a quarter of an acre. The trunks occupy the whole thickness of the coal seam, about a foot and a half, but do not pass through the shale above. Above this upper shale, there were remains of another forest, of similar character. One of the stumps examined was perfectly bituminized, and preserved its shape unflattened; it was four feet in circumference, and the roots spread to a distance of nearly two feet. The trunk and roots were covered with a bark about half an inch thick, which was rather brittle; the interior, two feet in diameter, was more earthy and concentrically lamellar. The trees were all upright, and are said by Mr. Beckett, to present undoubted evidence of having grown on the spot.

Mr. Wm. Ick, describing the same region, states that some of the trees are eight feet in circumference, and seventy are exposed to view on one area, broken off near the roots, while the prostrate trunks are lying across each other in every direction. One of these trunks was thirty feet in length. In a thickness of twelve feet, he distinguishes three beds of coal and remains of as many distinct forests. The trees are supposed to be Coniferæ.

37. *Phyllite.*—This mineral, which, as published by Alger, is probably identical with Ottrelite, was referred erroneously by Dr. Thomson, who first described it, to Sterling, Mass., whereas it was found by Prof. L. Vanuxem in the "town of Newport, R. I., where (in 1823) it occurred abundantly in 'mica shist,' in the stone walls of the enclosures, and also near the south ferry."

## III. Zoology and Botany.

1. *Report on Scientific Nomenclature*, (Proceedings of the Sixth Annual Meeting of the Assoc. of Am. Geol. and Nat. 1845, p. 69.)—Your Committee on Nomenclature having revised the laws and suggestions on this subject, published in the British Association, concur in recommending their general adoption. They have hesitated only with regard to writing names derived from persons or localities with an initial small letter instead of a capital. In citing the names of original discoverers in connection with that of a subsequent systematist by whom the original name had been changed, they have preferred, as most simple and concise, the plan which is proposed in the Report referred to, in a note to page 120, where this subject is discussed.

The following abstract has been made out in as concise a manner as possible, to secure more easy reference, and a more extended circulation: but they would strongly urge the perusal of the whole Report in the volume of the British Association for 1842, (pp. 105 to 121,) in which numerous examples are given by way of illustration, and the reasons for adopting the various laws are presented in a forcible and lucid manner.*

### I. Law of priority, with its limitations.

§ 1. The name originally given to a group or species by its founder, should be retained, to the exclusion of all subsequent synonyms.

The systematic nomenclature having originated with Linnæus, this law is not to extend to the writings of more ancient authors.

§ 2. In the progress of science it often becomes necessary to restrict or extend the characteristics of a genus, or subdivide a genus into several genera. The following principles bearing upon the above law, should be adopted in making such changes.

*a.* When several smaller genera are united in one, the name of the earliest, if otherwise unobjectionable, should be selected for the name of the whole group.

*b.* When a genus is subdivided, the original generic name should not be cancelled, but should be retained for that portion of it which was considered typical by the author: or if the evidence as to the original type is not clear and indisputable, it may be given to any portion of it.

*c.* When two authors define and name the same genus, *both making it exactly of the same extent*, the latter name should be cancelled *in toto*, and not retained in a modified sense: *except*, when its type (as laid down by its author) belongs to a different section of the genus from that of the other name, and both sections are elevated to genera.

For example—the genus *Monaulus* of Vieillot, (1816,) is a precise equivalent to the *Lophophorus* of Temminck, (1813,) both authors having adopted the same

* The Report is here given as it was finally adopted.

species as their type; and therefore, when the latter genus came, in the course of time, to be divided into two, it was incorrect to give the condemned name *Monaulus* to one of the portions. The names *Œdemia* and *Melanetta* were originally synonyms; but their respective types were taken from different sections of the group, and consequently, on raising these two sections to genera, these names are retained for the groups.

§ 3. There are other limitations of the law of priority, arising from violations of the rules of propriety in the introduction of names. They are as follows:—

*a.* Names given to species or groups unaccompanied by published characteristic descriptions, should yield place to the earliest name accompanying such descriptions.

It has been customary with some naturalists to give names to species in their cabinets, or in a published catalogue, and on this ground, to claim authority for such names. This should not be allowed. Neither is it sufficient that the description appear in a public newspaper, or in a journal not generally known for its scientific character, or in language so brief and indefinite that the object cannot be recognized by it.

*b.* A name of a species already in use for another species of the same genus, should be changed: also, a generic name in Zoology, before employed for a genus in that kingdom should be changed; and the same in the Vegetable kingdom.

*c.* A name glaringly opposed in its signification to the essential characteristics of a species or group, and likely to propagate important errors, may be changed.

Such terms as *Monodon*, *Caprimulgus*, *Paradisea apoda*, and *Monoculus*, have acquired sufficient currency no longer to cause error, and are therefore retained without inconvenience. Names derived from localities, where the species are found to have wider limits, should still be retained. But when we find a Batrachian reptile named in violation of its true affinities, *Mastodonsaurus*, or when a name is derived from an accidental monstrosity, as in *Picus semirostris* of Linnæus and *Helix disjuncta* of Turton, another name should be substituted. This privilege should be allowed only in extreme cases.

*d.* When the name of a species is afterwards made the name of a genus to include that species, a new specific name should be given.

The generic name *Pyrrhocorax* was applied to the species called by Linnæus, *Corvus pyrrhocorax*. It therefore became necessary to change the specific name, and *alpinus* was substituted. The practice of thus elevating specific names to generic is a bad one. See § 6, i.

II. LAWS WITH REGARD TO ORTHOGRAPHY.

§. 4. In writing systematic names, the rules of Latin orthography should be adhered to; *except* in words derived from proper names, in which only the termination should be latinized.

Proper names of persons would often become quite unintelligible if modified so as to conform throughout to Latin orthography. We should not recognize *Knighti*,

*Woodwardi*, in the words *Cnichti*, *Vudvardi*. But words of barbarous origin, having no fixed orthography, are more pliable, and hence when adopted into the Latin, should be rendered as classical in appearance as is consistent with the preservation of their original sound.

*a.* In converting Greek words into Latin the following principles should be regarded.

| Greek. | | Latin. | Greek. | | Latin. |
|---|---|---|---|---|---|
| αι | becomes | æ | θ | becomes | th |
| ει | " | i | φ | " | ph |
| ος terminal | " | us | χ | " | ch |
| ον " | " | um | κ | " | c |
| ου | " | u | γκ | " | nch |
| οι | " | œ | γγ | " | ng |
| υ | " | y | The aspirate (ʽ) | | h |

*b.* In compounding two Greek words, the first of the two words should have the form of the genitive case, dropping only the terminal consonant; as from ορνις, *bird*, and ρυγχος, *beak*, we have *Ornithorynchus*—not Ornirhynchus.

*c.* Words of different languages must never be compounded together. We add—

*d.* In compounding two Latin words, the same rule should be followed, except that *i* should be substituted when the genitive ends in *æ*; *pennæformis* should be *penniformis*.

*e.* Specific names, derived from localities, should terminate in *ensis*: those derived from names of persons, when given in honor of the discoverer, should end in the genitive *i*, or *ii*, (*i*, when the name ends in a consonant, and *ii* when in a vowel); but when in compliment to a person not a discoverer, the adjective should end in *anus*. But names derived from the names of persons or localities are very objectionable: see beyond, § 6, *b*, *c*.

### III. RECOMMENDATIONS FOR THE FUTURE IMPROVEMENT OF SYSTEMATIC NOMENCLATURE.

The following suggestions, although they cannot be invested with the authority of laws, are worthy of being strictly regarded in the future introduction of scientific names.

§ 5. The best names are those derived from the Greek or Latin language, the former being in general preferable for generic names, and the latter for specific.

§ 6. It is desirable,

*a.* To select names which may indicate some sensible characteristic of the object: this will greatly aid the memory.

*b.* To avoid specific names derived from localities.

*c.* To avoid invariably deriving generic and specific names from the names of persons.

*d.* To avoid comparative names, such as *Picoides*, *Emberizoides*, *maximus*, *minor*, *minimus*, &c.

*e.* To avoid ancient names of species, except when they can be correctly applied with their ancient signification.

*f.* To avoid names closely resembling others in use.

*g.* To avoid names having no meaning.

*h.* To avoid the introduction, under a new signification, of names that have been once ranked among synonyms, except in the cases alluded to in § 2, *c.*

*i.* To avoid making a generic name out of a former specific name.

*k.* To avoid introducing for a genus in Zoology a name already in use for a genus in Botany, and the reverse.

*l.* To avoid names of harsh and inelegant pronunciation.

§ 7. It is recommended that names of Families should end uniformly in *idæ*, and Subfamilies in *inæ*.

These names are formed by changing the last syllable of the genitive into *idæ* or *inæ*; as *Strix* gives *Strigidæ*, from the genitive *Strigis*, *Buceros* gives *Bucerotidæ*, from the genitive *Bucerotis*; not *Strixidæ*, *Bucerida*.

§ 8. It is recommended that generic names, and specific names which are derived from names of persons, be written with an initial capital; that all other specific names be written with a small initial letter.

This principle is introduced with reference to names of this kind already in use; for it is to be hoped that they may not be added to in future. (§ 6, *c.*)

§ 9. It is recommended that the original authority of a species always follow the name *in brackets*; and if the name be subsequently altered, the authority for the same as altered, be added without brackets.

It has been common for systematists to change a generic name, and then to add their own name to all the species. To prevent this injustice, which is no less than a kind of piracy, the above rule is proposed. As an example—the *Tyrannus crinitus* of Swainson is the *Muscicapa crinita* of Linnæus: to distinguish here the author of the former name and give due justice to Linnæus, it may be written, *Tyrannus crinitus*, (Linn.) Swain. By this we do not intimate whether the genus *Tyrannus* is Swainson's or not; it is sufficient for the purposes of science to show here that the above title, as a whole, was first adopted by Swainson. The authority for the genus will be found elsewhere.

§ 10. It is recommended that when an author, through ignorance of what his predecessors have done, gives to a species an appropriated specific name, the name of such author be omitted.

§ 11. It is recommended that when an author only corrects a false orthography, his name be not added as authority for the corrected term.

§ 12. It is recommended that in subdividing a genus, the new generic names proposed for the subdivisions formed, agree in gender with that of the original genus.

§ 13. It is recommended that in proposing new genera, the etymology of the names be always stated; and that one species be pointed out as a type or standard of reference.

§ 14. It is recommended that new genera and species be amply defined, and that the descriptions be inserted in such periodical or other works as are likely to obtain immediate and extensive circulation.

| | |
|---|---|
| James D. Dana. | A. Binney. |
| S. S. Haldeman. | C. U. Shepard. |
| D. H. Storer. | C. Dewey. |
| A. A. Gould. | J. D. Whelpley. |

E. C. Herrick.

2. *Aphides.*—Mr. Francis Walker of London is engaged in the preparation of a work on the Aphides of Great Britain.

3. *Caricography.*—In the third portion of Dr. Boott's memoir on new or little known Carices, read before the Linnæan Society of London in February last, seventeen species are described, the characters of which are given in the Proceedings of the Linn. Society, published in *Ann. and Mag. Nat. Hist.* for September. The following are natives of North America, viz. *Carex Geyeri*, gathered in the Rocky Mountains by C. A. Geyer;—allied to *C. phyllostachys: C. juncea*, Wild. (to which Dr. Boott refers *C. miser*, Buckley, described in this Journal): *C. Sullivantii*, first described in this Journal, vol. xlii, p. 29; and *C. Tuckermani*, (*C. bullata*, Tuckerm., not of *Schk.*)

4. *Fossil Ferns from Frostburg, Maryland, collected by Mr. Lyell;* by C. T. F. Bunbury, Esq., (Quart. Jour. Geol. Soc., ii, 82; read before the Geol. Soc. of London, Dec., 1845.)—Mr. Bunbury in a short memoir describes three species of ferns from Frostburg, two of which are figured. The first is supposed to be identical with the *Diplazites emarginatus* of Göppert. Mr. Bunbury shows that the genus Diplazites is founded on an error, and proposes to retain the species for the present in the genus Pecopteris, as P. emarginata, of which he gives the following description:

P. fronde pinnatâ (?): pinnis ligulatis obtusis latè et obtusissimè crenatis; basi subcontractis; costâ validâ apice attenuatâ; venis costæ subperpendicularibus pinnatis; venulis valdè obliquis, infimis in angulum acutum confluentibus; soris rotundis confertis inter venas biserialibus.

The second species is described as new, and named *Pecopteris elliptica.*

*Description.*—P. fronde bipinnatâ: pinnulis ellipticis oblongisque convexis integerrimis apice rotundatis basi contractis discretis remotiusculis; venis obliquis prope basin furcatis; soris subrotundis confertissimis. It is stated to be near the P.

adiantoides (Fossil Flora, i, 37) in the form of its pinnules; but the description of the latter is insufficient to determine their identity.

The third species agrees nearly with the *Danaites asplenioides* of Göppert, and is ranked for the present as a variety of it (var. *major*). This species is described as follows:

The frond appears to be bipinnate, and if a flattened stem (apparently the stipes of a fern) which occurs in the same slab belonged to this plant, it was of large size, for the stem in question, in its compressed state, measures an inch and a half across. The pinnules are closely set, oblique, rounded at the end, slightly combined at the base, but neither dilated nor decurrent, of an oblong or broadly linear form, flat, or scarcely convex, about four-tenths of an inch long, and about half as much in breadth. Veins very indistinctly marked, but seemingly nearly perpendicular to the margin. The fructiferous pinnules (which are on a separate pinna, but which I believe to belong to the same species) are rather larger than the others, but of the same shape; the fructification has the appearance of linear masses, placed parallel and nearly contiguous to one another, perpendicular to the midrib, and extending from it quite to the margin. Its general resemblance to the fructification of the curious genus *Danæa* is very striking, but I am not quite satisfied that it is really of the same nature; for on a close examination one may detect traces of round spots; and perhaps the apparently linear masses may have been made up by the aggregation of numerous round ones.

Mr. Bunbury remarks that "although the appearances of fructification in all these three plants are clear and unequivocal, yet in the first two species at least, it is invariably the upper surface of the frond that is exhibited to our view; now, in all recent ferns, the fructification is situated on the under surface: we must therefore suppose that what we see in these specimens are not the masses of capsules themselves, but the impressions of them, as it were, stamped through the substance of the leaves by the pressure to which they were subjected in the process of fossilization. This appears to be most usually the case with those fossil ferns which occur in a fertile state, and may be one reason why it is more difficult to determine with precision the characters of the fructification in these than in the recent plants. Dr. Lindley long ago observed,* that fossil ferns are much more often found with their upper than with their lower surface exposed to view, the lower seeming to adhere more closely to the matrix; and Professor Göppert,† in his curious experiments on the artificial production of vegetable impressions, found that plants of this tribe did, in fact, constantly remain attached to the substance in which they were imbedded, by their lower and not by their upper surface, especially if they were in fructification.

The other plants procured by Mr. Lyell are the Neuropteris cordata, N. gigantea ?, Cyclopteris (?), Pecopteris arborescens, P. abbreviata ?, P. —— ?, Lepidodendron tetragonum, L. aculeatum, L. —— ? ?, Sigillaria reniformis ?, Stigmaria ficoides, Asterophyllites foliosa, A. tuberculata ?, A. equisetiformis ?, A. —— ?, Artisia —— ?, Calamites nodosus, C. dubius ?.

* Fossil Flora, text to t. 83. † Syst. Filicum Fossilium, p. 293.

## IV. Meteorology.

1. *Abstract of a Meteorological Register kept in the city of Natchez, Lat. 31° 34′, Lon. 91° 21′ 42″, for ten years; to show the monthly and annual mean, maximum and minimum of the thermometer and barometer, the weather, prevailing winds, and depth of rain;* by Henry Tooley, Sen.

| Months. | Thermometer. | | | Barometer. | | | Weather and Days. | | | Prevailing winds. | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean. | Max. | Min. | Mean. | Max. | Min. | Clear. | Cloudy. | Rainy. | S. | S.W. | S.E. | E. | N. | N.E. | N.W. | W. |
| 1836. | | | | | | | | | | | | | | | | | |
| January, | 51·4 | 69·5 | 34·5 | 29·783 | 30·105 | 29·485 | 8 | 8 | 15 | 12 | 3 | 0 | 4 | 14 | 1 | 2 | 2 |
| February, | 53·3 | 63· | 35·5 | ·797 | ·155 | ·545 | 6 | 12 | 11 | 12 | 1 | 3 | 6 | 12 | 4 | 1 | 1 |
| March, | 56·4 | 72· | 41·5 | ·798 | ·075 | ·440 | 7 | 13 | 11 | 12 | 2 | 2 | 5 | 13 | 2 | 2 | 0 |
| April, | 70·6 | 75·5 | 60· | .705 | 29·930 | ·535 | 6 | 12 | 12 | 22 | 5 | 0 | 4 | 10 | 0 | 0 | 1 |
| May, | 73·6 | 77·5 | 68· | ·646 | ·800 | ·350 | 2 | 17 | 12 | 19 | 8 | 0 | 6 | 7 | 2 | 1 | 0 |
| June, | 78·6 | 82·5 | 76· | ·670 | ·773 | ·550 | 3 | 16 | 11 | 19 | 7 | 1 | 0 | 7 | 0 | 3 | 2 |
| July, | 81·5 | 85·2 | 74·2 | ·704 | ·745 | ·525 | 2 | 19 | 10 | 16 | 15 | 0 | 3 | 7 | 4 | 0 | 1 |
| August, | 81·3 | 85·5 | 75·5 | ·725 | ·810 | ·575 | 7 | 14 | 10 | 12 | 6 | 3 | 9 | 14 | 1 | 4 | 9 |
| September, | 77·4 | 81· | 68· | ·724 | ·840 | ·560 | 2 | 14 | 14 | 10 | 8 | 8 | 14 | 10 | 3 | 0 | 1 |
| October, | 61·4 | 74· | 49· | ·778 | ·820 | ·565 | 13 | 14 | 4 | 4 | 6 | 5 | 4 | 17 | 5 | 0 | 1 |
| November, | 52·6 | 67· | 39·5 | ·809 | 30·040 | ·490 | 10 | 16 | 4 | 4 | 2 | 3 | 6 | 9 | 0 | 1 | 12 |
| December, | 46·2 | 64· | 26·5 | ·807 | ·300 | ·610 | 10 | 13 | 8 | 10 | 3 | 8 | 9 | 11 | 0 | 0 | 4 |
| | 65·3 | 74·7 | 54· | 29·743 | 29·946 | 29·519 | 76 | 168 | 122 | 154 | 66 | 33 | 72 | 131 | 20 | 14 | 34 |
| 1837. | | | | | | | | | | | | | | | | | |
| January, | 47·2 | 50· | 35·3 | 29·753 | 29·966 | 29·500 | 11 | 7 | 13 | 8 | 6 | 3 | 5 | 16 | 7 | 2 | 11 |
| February, | 52·3 | 62·6 | 39· | ·688 | 30·170 | ·600 | 8 | 10 | 10 | 10 | 3 | 5 | 14 | 15 | 4 | 8 | 11 |
| March, | 59·5 | 69·3 | 49 3 | ·773 | ·103 | ·540 | 7 | 12 | 12 | 12 | 5 | 8 | 15 | 22 | 2 | 5 | 1 |
| April, | 64·3 | 74· | 50· | ·686 | ·013 | ·246 | 10 | 14 | 6 | 15 | 13 | 1 | 10 | 19 | 4 | 3 | 7 |
| May, | 73· | 81·6 | 61· | ·697 | 29·833 | ·530 | 23 | 4 | 4 | 24 | 14 | 4 | 8 | 18 | 1 | 3 | 11 |
| June, | 80·7 | 87· | 72· | ·680 | ·826 | ·540 | 5 | 18 | 7 | 18 | 35 | 13 | 6 | 10 | 0 | 0 | 1 |
| July, | 83·3 | 86·3 | 79· | ·764 | ·835 | ·693 | 0 | 21 | 10 | 14 | 14 | 6 | 5 | 10 | 3 | 4 | 6 |
| August, | 83·2 | 87·3 | 76·1 | ·777 | ·883 | ·583 | 0 | 25 | 6 | 4 | 6 | 2 | 10 | 17 | 6 | 3 | 6 |
| September, | 75·4 | 76·5 | 63·4 | ·764 | ·912 | ·662 | 4 | 16 | 10 | 1 | 8 | 8 | 17 | 7 | 5 | 1 | 3 |
| October, | 67·5 | 74·8 | 47·6 | ·883 | 30·116 | ·573 | 8 | 18 | 5 | 6 | 8 | 4 | 15 | 17 | 2 | 1 | 1 |
| November, | 63·5 | 71·3 | 47·3 | ·821 | ·070 | ·673 | 11 | 13 | 6 | 11 | 5 | 10 | 12 | 8 | 1 | 1 | 3 |
| December, | 53·7 | 57·6 | 38· | ·614 | ·270 | ·470 | 7 | 15 | 9 | 6 | 6 | 2 | 7 | 14 | 2 | 3 | 4 |
| | 66·9 | 72·8 | 54·6 | 29·741 | 29·999 | 29·550 | 94 | 173 | 108 | 129 | 123 | 66 | 124 | 173 | 87 | 34 | 65 |
| 1838. | | | | | | | | | | | | | | | | | |
| January, | 51·6 | 68· | 33· | 30·040 | 30·376 | 29·666 | 5 | 18 | 8 | 8 | 4 | 7 | 4 | 12 | 2 | 2 | 0 |
| February, | 42·3 | 61·4 | 22.3 | 29·902 | ·253 | ·606 | 4 | 12 | 12 | 1 | 8 | 6 | 2 | 15 | 2 | 1 | 3 |
| March, | 60·8 | 73·3 | 43·3 | ·743 | ·030 | ·463 | 2 | 23 | 6 | 6 | 9 | 6 | 6 | 4 | 3 | 3 | 8 |
| April, | 69·3 | 73· | 60·6 | ·708 | 29·999 | ·516 | 2 | 24 | 4 | 11 | 7 | 1 | 7 | 8 | 6 | 3 | 3 |
| May, | 68·4 | 75·3 | 60· | ·679 | ·850 | ·546 | 1 | 17 | 13 | 5 | 5 | 9 | 2 | 5 | 5 | 2 | 6 |
| June, | 82· | 86·6 | 70·6 | ·700 | ·813 | ·493 | 1 | 27 | 2 | 8 | 12 | 5 | 3 | 9 | 1 | 4 | 8 |
| July, | 81 3 | 85· | 78·3 | ·793 | ·836 | ·706 | 0 | 19 | 12 | 17 | 8 | 10 | 8 | 7 | 0 | 2 | 14 |
| August, | 80·8 | 84·3 | 79·6 | ·742 | ·806 | ·690 | 0 | 19 | 12 | 10 | 11 | 7 | 5 | 2 | 3 | 3 | 6 |
| September, | 73·8 | 87·3 | 60·6 | .706 | ·950 | ·520 | 10 | 14 | 6 | 0 | 2 | 2 | 11 | 21 | 9 | 5 | 2 |
| October, | 62·4 | 78·6 | 53·3 | ·825 | 30·010 | ·730 | 8 | 15 | 8 | 4 | 10 | 2 | 8 | 12 | 5 | 0 | 2 |
| November, | 52·7 | 68·3 | 41· | ·884 | ·211 | ·540 | 5 | 18 | 7 | 6 | 4 | 2 | 7 | 14 | 3 | 3 | 1 |
| December, | 44·7 | 57·6 | 28·3 | 30·028 | ·246 | ·640 | 5 | 19 | 7 | 8 | 7 | 4 | 3 | 17 | 2 | 2 | 0 |
| | 64·1 | 74·3 | 53·4 | 29·788 | 30·002 | 29·593 | 53 | 225 | 97 | 84 | 87 | 61 | 67 | 132 | 41 | 30 | 53 |
| 1839. | | | | | | | | | | | | | | | | | |
| January, | 52·6 | 64·3 | 41· | 29·728 | 30·160 | 29·513 | 0 | 21 | 10 | 12 | 5 | 5 | 2 | 11 | 2 | 6 | 6 |
| February, | 50·8 | 64· | 38· | ·693 | ·460 | ·543 | 5 | 13 | 10 | 2 | 6 | 4 | 4 | 9 | 7 | 4 | 6 |
| March, | 59·3 | 72· | 32·6 | ·907 | ·403 | ·436 | 2 | 19 | 10 | 17 | 6 | 6 | 5 | 10 | 0 | 5 | 6 |
| April, | 75·1 | 77·7 | 61·6 | ·722 | 29·923 | ·563 | 2 | 24 | 4 | 12 | 8 | 12 | 4 | 2 | 2 | 3 | 3 |
| May, | 76·7 | 84· | 64·6 | ·702 | ·933 | ·546 | 4 | 20 | 7 | 11 | 18 | 2 | 5 | 7 | 3 | 2 | 3 |
| June, | 82·6 | 85 6 | 73·6 | ·778 | ·830 | ·566 | 0 | 26 | 4 | 8 | 20 | 3 | 1 | 6 | 1 | 0 | 6 |
| July, | 83·8 | 87· | 77·3 | ·701 | ·870 | .660 | 0 | 23 | 8 | 10 | 14 | 5 | 9 | 8 | 1 | 0 | 4 |
| August, | 81·4 | 83· | 76·3 | ·730 | ·793 | ·656 | 2 | 23 | 6 | 10 | 12 | 4 | 15 | 8 | 5 | 4 | 5 |
| September, | 77· | 85·3 | 75·3 | ·797 | ·920 | ·563 | 4 | 23 | 3 | 6 | 12 | 5 | 4 | 9 | 12 | 2 | 1 |
| October, | 71·6 | 77·6 | 63·1 | ·819 | ·956 | ·620 | 8 | 20 | 3 | 7 | 7 | 11 | 13 | 14 | 2 | 1 | 0 |
| November, | 52·7 | 72· | 29·3 | ·841 | 30·326 | ·783 | 3 | 17 | 10 | 8 | 5 | 3 | 7 | 14 | 4 | 0 | 4 |
| December, | 46·8 | 49·6 | 41· | ·833 | ·160 | ·486 | 8 | 14 | 9 | 4 | 7 | 6 | 8 | 14 | 5 | 4 | 5 |
| | 67·8 | 75·1 | 56·1 | 29·771 | 29·999 | 29·579 | 38 | 243 | 84 | 107 | 120 | 66 | 77 | 112 | 44 | 28 | 49 |

| Months. | Thermomet'r. | | | Barometer. | | | Weather and Days. | | | Prevailing Winds. | | | | | | | | Rain. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean. | Max. | Min. | Mean. | Max. | Min. | Clear. | Cloudy. | Rainy. | S. | S.W. | S.E. | E. | N. | N.E. | N.W. | W. | Inch. |
| 1840. | | | | | | | | | | | | | | | | | | |
| Jan'ry, | 49·4 | 65· | 31·6 | 29·901 | 30·300 | 29·603 | 7 | 16 | 8 | 8 | 9 | 5 | 4 | 10 | 2 | 0 | 4 | 3·52 |
| Feb'ry, | 56·8 | 67· | 32· | ·911 | ·370 | ·573 | 2 | 15 | 12 | 14 | 4 | 3 | 7 | 5 | 2 | 1 | 1 | 3·04 |
| March, | 61·5 | 74·6 | 53·3 | ·728 | 29·936 | ·550 | 2 | 17 | 12 | 17 | 9 | 5 | 7 | 11 | 1 | 5 | 4 | 3·50 |
| April, | 71·2 | 80 6 | 57·3 | ·803 | ·978 | ·776 | 0 | 19 | 11 | 20 | 11 | 5 | 7 | 6 | 2 | 0 | 5 | 8.73 |
| May, | 72 5 | 78·3 | 62· | ·659 | ·960 | ·450 | 2 | 25 | 4 | 11 | 9 | 2 | 13 | 6 | 5 | 3 | 5 | 2·25 |
| June, | 81·2 | 86·6 | 73·3 | ·756 | ·953 | ·690 | 3 | 18 | 9 | 14 | 7 | 1 | 11 | 3 | 0 | 1 | 7 | 4·19 |
| July, | 82·2 | 85· | 76· | ·799 | ·866 | ·753 | 0 | 17 | 14 | 16 | 14 | 8 | 9 | 14 | 3 | 2 | 0 | 7·70 |
| Aug'st, | 82·6 | 88·3 | 77· | ·774 | ·903 | ·729 | 0 | 28 | 3 | 13 | 7 | 5 | 2 | 13 | 5 | 2 | 11 | ·75 |
| Sept. | 75·9 | 82· | 66·3 | ·795 | ·903 | ·736 | 3 | 21 | 6 | 5 | 4 | 10 | 7 | 19 | 15 | 2 | 4 | 3·90 |
| Oct. | 68·5 | 80· | 51·3 | ·744 | 30·126 | ·653 | 4 | 21 | 6 | 13 | 6 | 8 | 7 | 16 | 4 | 4 | 7 | 4·68 |
| Nov. | 53· | 71·3 | 33·3 | ·862 | ·116 | ·520 | 11 | 15 | 4 | 17 | 7 | 8 | 14 | 12 | 2 | 2 | 7 | 1·88 |
| Dec. | 50·2 | 64· | 37. | ·941 | ·146 | ·708 | 3 | 22 | 6 | 7 | 6 | 8 | 15 | 14 | 7 | 1 | 3 | 4·28 |
| | 67·1 | 76·8 | 46·7 | 29·806 | 30·046 | 29·644 | 37 | 234 | 95 | 155 | 93 | 68 | 103 | 130 | 48 | 23 | 58 | 48·48 |
| 1841. | | | | | | | | | | | | | | | | | | |
| Jan'ry, | 47·1 | 65·6 | 25·3 | 29·771 | 30·176 | 29·400 | 1 | 14 | 16 | 8 | 6 | 10 | 9 | 11 | 6 | 4 | 7 | 13·80 |
| Feb'ry, | 54·6 | 67·3 | 30·3 | ·771 | ·206 | ·450 | 4 | 21 | 3 | 12 | 9 | 5 | 4 | 12 | 4 | 5 | 3 | 1·31 |
| March, | 61·2 | 70·6 | 39· | ·738 | ·093 | ·400 | 4 | 17 | 10 | 11 | 7 | 19 | 8 | 5 | 0 | 5 | 7 | 4·73 |
| April, | 71· | 77·3 | 62·6 | ·759 | 29·943 | ·486 | 0 | 21 | 9 | 12 | 14 | 9 | 5 | 8 | 1 | 2 | 14 | 2·16 |
| May, | 75 3 | 79·6 | 69· | ·771 | ·960 | ·590 | 4 | 20 | 7 | 15 | 8 | 10 | 11 | 12 | 9 | 3 | 2 | 11·66 |
| June, | 81·5 | 85 3 | 74· | ·713 | ·838 | ·640 | 0 | 20 | 10 | 12 | 16 | 7 | 6 | 12 | 5 | 5 | 5 | 2·12 |
| July, | 84·8 | 90· | 81· | ·831 | ·888 | ·740 | 0 | 24 | 7 | 14 | 20 | 3 | 5 | 12 | 1 | 3 | 6 | 1·44 |
| Aug'st, | 81 6 | 86 6 | 79·6 | ·808 | ·920 | ·703 | 4 | 18 | 9 | 7 | 6 | 10 | 14 | 20 | 2 | 2 | 5 | 3·05 |
| Sept. | 77·8 | 84·3 | 63·6 | ·730 | ·860 | ·620 | 2 | 19 | 9 | 10 | 8 | 12 | 3 | 11 | 4 | 2 | 2 | 4·32 |
| Oct. | 66·6 | 76·3 | 47·3 | ·840 | 30·186 | ·653 | 7 | 19 | 5 | 5 | 5 | 11 | 12 | 14 | 7 | 2 | 2 | 8·62 |
| Nov. | 59·7 | 75· | 36·3 | ·827 | ·153 | ·516 | 9 | 17 | 4 | 8 | 4 | 7 | 9 | 13 | 2 | 2 | 2 | 2·53 |
| Dec. | 54·3 | 71· | 35· | ·883 | ·156 | ·580 | 7 | 14 | 10 | 9 | 7 | 7 | 4 | 11 | 4 | 1 | 4 | 4·01 |
| | 68· | 76·5 | 53·5 | 29·786 | 30·031 | 29·682 | 42 | 214 | 99 | 123 | 110 | 110 | 89 | 137 | 45 | 36 | 59 | 59·78 |
| 1842. | | | | | | | | | | | | | | | | | | |
| Jan'ry, | 54·9 | 71·3 | 44·3 | 29·888 | 30·093 | 29·660 | 5 | 16 | 10 | 9 | 12 | 7 | 4 | 8 | 4 | 0 | 5 | 3·52 |
| Feb'ry, | 54·2 | 71·3 | 41·3 | ·820 | ·133 | ·433 | 6 | 13 | 9 | 13 | 4 | 6 | 4 | 7 | 2 | 2 | 5 | 7·31 |
| March, | 69·1 | 76· | 58·3 | ·889 | 30·270 | ·496 | 2 | 20 | 9 | 19 | 11 | 8 | 8 | 6 | 2 | 0 | 1 | 3·93 |
| April, | 70·9 | 74·3 | 56·3 | ·828 | 29·970 | ·496 | 6 | 16 | 8 | 16 | 10 | 7 | 3 | 9 | 1 | 5 | 5 | 5·07 |
| May, | 76·9 | 83·3 | 64·3 | ·832 | 30·056 | ·640 | 3 | 25 | 3 | 23 | 19 | 1 | 4 | 8 | 0 | 0 | 0 | ·45 |
| June, | 81·5 | 85· | 79·6 | ·781 | 29·863 | ·670 | 1 | 20 | 9 | 22 | 16 | 5 | 7 | 6 | 2 | 0 | 5 | 6·40 |
| July, | 80·1 | 86· | 71· | ·857 | ·940 | ·696 | 0 | 24 | 7 | 10 | 14 | 7 | 9 | 13 | 0 | 0 | 4 | 1·74 |
| Aug'st, | 78·9 | 82·6 | 78·6 | ·818 | ·940 | ·696 | 2 | 19 | 10 | 16 | 7 | 2 | 9 | 9 | 3 | 1 | 5 | 1·94 |
| Sept. | 77·4 | 82·3 | 70·6 | ·754 | ·873 | ·690 | 0 | 18 | 12 | 9 | 2 | 17 | 10 | 7 | 8 | 0 | 1 | 4·64 |
| Oct. | 66·9 | 75· | 53·6 | ·866 | ·993 | ·666 | 10 | 17 | 4 | 5 | 6 | 11 | 5 | 13 | 5 | 0 | 0 | 1·73 |
| Nov. | 54· | 65· | 32·6 | ·870 | 30·236 | ·516 | 2 | 19 | 9 | 4 | 4 | 12 | 8 | 13 | 1 | 2 | 3 | 5·42 |
| Dec. | 50·6 | 71· | 34·3 | ·966 | ·316 | ·733 | 2 | 27 | 2 | 8 | 5 | 6 | 4 | 4 | 3 | 3 | 7 | 1·37 |
| | 67·4 | 76·8 | 56·9 | 29·847 | 30·056 | 29·623 | 39 | 234 | 92 | 154 | 110 | 89 | 75 | 103 | 31 | 13 | 41 | 43·52 |
| 1843. | | | | | | | | | | | | | | | | | | |
| Jan'ry, | 54· | 66·6 | 33 3 | 29·911 | 30·070 | 29·620 | 6 | 20 | 5 | 10 | 7 | 9 | 7 | 8 | 2 | 2 | 5 | 7·20 |
| Feb'ry, | 50·4 | 69·6 | 26· | ·788 | ·043 | ·613 | 4 | 20 | 4 | 9 | 7 | 2 | 10 | 8 | 4 | 1 | 1 | 3·70 |
| March, | 46·8 | 64· | 30 6 | ·791 | ·016 | ·576 | 5 | 18 | 8 | 8 | 5 | 8 | 9 | 17 | 5 | 4 | 5 | 6·06 |
| April, | 70·6 | 79·6 | 51· | ·774 | 29·920 | ·646 | 3 | 23 | 4 | 16 | 11 | 3 | 7 | 4 | 3 | 1 | 2 | 5·16 |
| May, | 75 9 | 83·3 | 68·3 | ·789 | ·926 | ·629 | 7 | 18 | 6 | 17 | 11 | 9 | 2 | 8 | 7 | 2 | 0 | 2·16 |
| June, | 78·9 | 83·3 | 75·3 | ·784 | ·876 | ·583 | 0 | 16 | 14 | 8 | 14 | 13 | 12 | 6 | 1 | 0 | 5 | 10·68 |
| July, | 81· | 86·3 | 78·5 | ·822 | 30·013 | ·733 | 1 | 20 | 10 | 5 | 16 | 19 | 1 | 10 | 1 | 0 | 4 | 6·75 |
| Aug'st, | 79·4 | 83·3 | 75·3 | ·830 | 29·903 | ·430 | 1 | 21 | 9 | 5 | 6 | 9 | 8 | 17 | 4 | 0 | 8 | 2·78 |
| Sept. | 79·6 | 83·6 | 73·3 | ·796 | ·976 | ·660 | 0 | 18 | 12 | 9 | 12 | 18 | 6 | 3 | 5 | 0 | 4 | 4·93 |
| Oct. | 63·9 | 74·9 | 42·6 | ·831 | 30·136 | ·616 | 4 | 20 | 7 | 9 | 9 | 8 | 9 | 6 | 3 | 1 | 2 | 4·04 |
| Nov. | 60·9 | 73·6 | 48·6 | ·852 | ·066 | ·700 | 0 | 18 | 12 | 10 | 4 | 11 | 4 | 11 | 4 | 0 | 0 | 11·24 |
| Dec. | 51·8 | 64·6 | 41·6 | ·913 | ·300 | ·706 | 7 | 9 | 15 | 4 | 5 | 6 | 8 | 15 | 3 | 1 | 4 | 14·03 |
| | 66·1 | 76·3 | 53·7 | 29·721 | 30·020 | 29·625 | 38 | 221 | 106 | 120 | 107 | 115 | 83 | 113 | 42 | 12 | 40 | 78·73 |

| Months. | Thermometer. Mean. | Max. | Min. | Barometer. Mean. | Max. | Min. | Weather and Days. Clear. | Cloudy. | Rainy. | Prevailing Winds. S. | S.W. | S.E | E. | N. | N.E. | N.W. | W. | Rain. Inch |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1844. | | | | | | | | | | | | | | | | | | |
| Jan'ry, | 53·2 | 69·3 | 40·6 | 29·831 | 30·086 | 29·500 | 4 | 12 | 15 | 6 | 15 | 9 | 8 | 11 | 1 | 5 | 1 | 8·37 |
| Feb'ry, | 59· | 72· | 44· | ·941 | ·130 | ·630 | 3 | 25 | 1 | 11 | 12 | 8 | 4 | 8 | 4 | 0 | 1 | ·05 |
| March, | 59.9 | 75·6 | 50· | ·875 | ·133 | ·533 | 7 | 15 | 9 | 13 | 8 | 7 | 3 | 7 | 2 | 2 | 10 | 4·18 |
| April, | 71·2 | 80·3 | 59· | ·870 | ·140 | ·666 | 1 | 25 | 4 | 26 | 9 | 10 | 1 | 4 | 0 | 0 | 1 | ·72 |
| May, | 77·9 | 83· | 79· | ·853 | ·046 | ·538 | 0 | 19 | 12 | 22 | 21 | 3 | 2 | 2 | 1 | 1 | 2 | 4·36 |
| June, | 80·6 | 83· | 76·3 | ·809 | 29·836 | ·740 | 0 | 23 | 7 | 22 | 8 | 9 | 5 | 2 | 0 | 0 | 3 | 2·51 |
| July, | 84·2 | 86·6 | 81· | ·826 | ·930 | ·716 | 0 | 22 | 9 | 22 | 20 | 3 | 7 | 5 | 0 | 0 | 3 | 2·34 |
| Aug'st, | 80·6 | 86·6 | 77.3 | ·762 | ·943 | ·660 | 1 | 18 | 12 | 14 | 11 | 8 | 12 | 9 | 4 | 1 | 3 | 4·79 |
| Sept. | 76·6 | 85· | 55. | ·837 | ·980 | ·753 | 2 | 24 | 4 | 5 | 1 | 6 | 15 | 15 | 2 | 2 | 0 | 3·94 |
| Oct. | 66·6 | 75·3 | 48·3 | ·829 | 30·040 | ·620 | 1 | 26 | 4 | 7 | 7 | 8 | 11 | 13 | 2 | 1 | 1 | 5·34 |
| Nov. | 59·2 | 74·3 | 46·6 | ·853 | ·060 | ·630 | 3 | 21 | 6 | 14 | 6 | 7 | 9 | 10 | 0 | 0 | 0 | 4·38 |
| Dec. | 50·5 | 60·6 | 35·3 | ·908 | ·136 | ·583 | 13 | 13 | 5 | 11 | 11 | 3 | 4 | 13 | 0 | 2 | 3 | 4·90 |
| | 68·2 | 77·6 | 57. | 29·851 | 30·030 | 29·632 | 35 | 243 | 88 | 173 | 129 | 81 | 81 | 99 | 16 | 14 | 28 | 45·91 |
| 1845. | | | | | | | | | | | | | | | | | | |
| Jan'ry, | 54·9 | 67·6 | 46·3 | 29·893 | 30·316 | 29·703 | 4 | 21 | 6 | 14 | 8 | 6 | 6 | 8 | 8 | 1 | 6 | 3·10 |
| Feb'ry, | 56·8 | 69·6 | 43· | ·920 | ·193 | ·613 | 6 | 16 | 6 | 16 | 3 | 8 | 4 | 7 | 0 | 1 | 2 | 4·65 |
| March, | 62·2 | 71·3 | 46· | ·896 | ·263 | ·813 | 3 | 15 | 13 | 14 | 3 | 7 | 8 | 11 | 1 | 0 | 6 | 6·43 |
| April, | 69·4 | 79·3 | 59· | ·854 | ·016 | ·706 | 4 | 18 | 8 | 22 | 7 | 9 | 7 | 3 | 1 | 0 | 0 | 4·10 |
| May, | 74·1 | 77·3 | 65 3 | ·827 | ·026 | ·703 | 3 | 21 | 7 | 11 | 9 | 9 | 13 | 4 | 4 | 0 | 0 | 8·19 |
| June, | 81·5 | 86· | 76· | ·888 | 29·990 | ·803 | 0 | 21 | 9 | 21 | 15 | 8 | 2 | 2 | 1 | 0 | 1 | 3·47 |
| July, | 82·7 | 90· | 78· | ·831 | ·953 | ·716 | 3 | 16 | 12 | 18 | 14 | 6 | 3 | 9 | 2 | 1 | 6 | 3·98 |
| Aug'st, | 81·6 | 88·3 | 78· | ·843 | ·966 | ·706 | 3 | 20 | 8 | 23 | 11 | 7 | 6 | 10 | 2 | 2 | 3 | 2·68 |
| Sept. | 76·8 | 80·6 | 65·3 | ·818 | ·890 | ·663 | 7 | 13 | 10 | 16 | 3 | 5 | 12 | 9 | 2 | 2 | 0 | 9·35 |
| Oct. | 64·7 | 72·6 | 54·6 | ·807 | 30·158 | ·666 | 8 | 19 | 4 | 6 | 1 | 10 | 15 | 10 | 1 | 4 | 6 | 1·24 |
| Nov. | 56·2 | 71. | 35· | ·860 | ·059 | ·666 | 4 | 19 | 7 | 18 | 2 | 4 | 7 | 14 | 1 | 1 | 5 | ·87 |
| Dec. | 44·5 | 67.4 | 25· | ·968 | ·194 | ·736 | 5 | 16 | 10 | 7 | 2 | 6 | 3 | 17 | 4 | 2 | 0 | 4·44 |
| | 67·1 | 76·7 | 51·4 | 29·874 | 30·083 | 29·707 | 50 | 215 | 100 | 181 | 78 | 80 | 84 | 104 | 27 | 14 | 35 | 53·10 |

RECAPITULATION.

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1836, | 65·3 | 74·7 | 54· | 29·743 | 29·946 | 29·519 | 76 | 168 | 122 | | | | | | | | | |
| 1837, | 66·9 | 72·8 | 54·6 | ·741 | ·999 | ·550 | 94 | 173 | 103 | | | | | | | | | |
| 1838, | 64·1 | 74·3 | 53·4 | ·788 | 30·002 | ·593 | 53 | 223 | 97 | | | | | | | | | |
| 1839, | 67·8 | 75·1 | 56·1 | ·771 | 29·999 | ·579 | 38 | 243 | 84 | | | | | | | | | |
| 1840, | 67·1 | 76·5 | 46·7 | ·806 | 30·046 | ·644 | 37 | 234 | 95 | | | | | | | | | 48·48 |
| 1841, | 68· | 76·5 | 53·5 | ·786 | ·031 | ·482 | 42 | 214 | 99 | | | | | | | | | 59·78 |
| 1842, | 67·9 | 76·8 | 56·9 | ·847 | ·056 | ·623 | 39 | 234 | 92 | | | | | | | | | 43·52 |
| 1843, | 66·1 | 76·3 | 53·7 | ·721 | ·020 | ·625 | 38 | 221 | 106 | | | | | | | | | 78·73 |
| 1844, | 68·2 | 77·6 | 57· | ·851 | ·030 | ·632 | 35 | 243 | 88 | | | | | | | | | 45·91 |
| 1845, | 67·1 | 76·7 | 51·4 | ·814 | ·083 | ·702 | 50 | 215 | 100 | | | | | | | | | 53·10 |
| Mean for 10 ys | 66·8 | 75·7 | 54·4 | 29·792 | 30·021 | 29·595 | 49·7 | 216·8 | 99·1 | Mean depth of rain for 6 y'rs, | | | | | | | | 54·92 |

## Remarks.

The foregoing tables are designed to show the mean, maximum, and minimum, of the Thermometer and Barometer, the number of clear, cloudy and wet days, the prevailing winds, and depth of rain, for ten years in the city of Natchez. These tables show clearly that the climate is good, and conducive to life and health, and all other blessings that heart can desire. With the exception of occasional epidemics, far between, Natchez is as healthy a city as can be found in the same parallel of latitude around the world, proved by the multitude and healthiness of the children; and where temperance, industry and good behavior are observed by the adult citizens, they are as healthy and long lived as in any part of the United States, let that part be where it

may. Extremes of heat and cold, dry and wet weather are unknown. Injurious drought and heavy rains are rare. Within the last thirteen years, there have been eight destructive fires in the city, seven of which were followed by rain more or less heavy. These facts are mentioned as probable confirmation of Professor Espy's doctrine upon the subject; but whether true or not, let every one judge for himself.

Natchez, Aug. 12, 1846.

2. *Variations in the climate of France*; (L'Institut, No. 647.)—M. Dureau de Lamalle, in May last, read a memoir before the French Academy, in which he contested the value of the citations taken from ancient authors by M. Fuster adduced to prove that the mean temperature of France had diminished.

## V. Astronomy.

1. *Atmosphere of the Moon*; (from an article on the Physical Constitution of the Moon, by Prof. E. Loomis, in the Sidereal Messenger, Cincinnati, i, p. 20.)—Whether we observe the moon with the naked eye or with the most powerful telescope, we have no difficulty in saying precisely where day ceases and night begins. The shadows of the lunar mountains are dark as midnight.—The transition seems instantaneous from midnight to noonday. We conclude that the moon has no twilight—or rather the legitimate conclusion is, that the moon has no twilight which can be appreciated by this mode of observation. More refined methods of observation have disclosed the existence of a feeble twilight. If there was no atmosphere, the line which joins the extremities of the horns of the new moon should pass exactly through the centre of the disc—that is, the ring of light should be an exact semicircle. By observing the moon when her phases were extremely falcated, Schröter discovered a faint glimmering light extending from both the cusps beyond the semicircle. The greatest breadth of this twilight was two seconds, corresponding to about two miles on the moon's surface.—We admit then that the moon has a twilight, extending about two miles in breadth, from which we compute that the height of the denser part of the moon's atmosphere is 1500 feet.

When the edge of the moon's disc approaches a star, the instant before its disappearance, its light must pass through the moon's atmosphere, if there be any, and suffer *refraction*. The light of the star, instead of moving in a straight line, must be bent behind the moon, and the star must be seen later than it would be without refraction. The contrary effect must take place at emersion; the star must re-appear sooner than it should if there were no refraction—in other words, the *duration* of an occultation is diminished by refraction. Now it is easy to bring this question to the test of experiment. We can compute the

time required by the moon to move over a space equal to its diameter, and we have but to compare with this, the time of the star's disappearance. This observation has been repeated a thousand times, and the result is, that the two intervals are almost identically the same. For a long time it was considered doubtful whether there was any appreciable difference; but astronomers are now generally inclined to the opinion that there is a difference of a few seconds. This would indicate that the moon's atmosphere does refract light; but the effect is exceedingly small. The refraction produced by the earth's atmosphere is more than a thousand times greater than that of the moon. The pressure of the moon's atmosphere would be balanced by a column of mercury one forty-fifth ($\frac{1}{45}$) part of an inch in height. The best French air-pumps are warranted to rarefy air to one twenty-fifth ($\frac{1}{25}$) part of an inch of mercury. * * If we use language with the utmost precision, we must say the moon *has* an atmosphere; but to avoid being misunderstood, we should add, that *it is more rare than any we can produce with our best air-pumps.*

2. *On the Projection of a Star on the Dark Limb of the Moon just before its Occultation;* by Prof. STEVELLY, (Rep. Brit. Assoc., 1845, p. 5.)—This the Professor considered to be a result of diffraction. Sir Isaac Newton having observed the shadow of a hair placed in a strong beam of sunlight to be broader than the hair itself, was led to investigate the course of a ray as it passed by the edge of a body, like the edge of a knife placed across a hole in the window-shutter, through which a sunbeam is admitted. Beyond a certain distance the rays proceeded in their usual straight courses; at that distance they were bent towards the edge; but the courses of the nearest rays were bent away from the edge, so as to form curves convex towards it. The undulatory theory enables us to trace these curves, and they are known to be of the nature of the hyperbola, with asymptotic branches extending onwards from the diffracting edge. Prof. Stevelly conceived the dark limb of the moon to be such a diffracting edge to the slender beam of light which reached us from a fixed star; and that as the curve was, at the last moment the light was allowed to pass, convex towards the moon, the portion of the ray which last enters our eye before the star disappears, being the direction in which we should then see the star, if produced backwards, would meet the moon on her dark surface.

3. *The Central Sun of the Universe.*—Prof. Mädler of Dorpat has announced that he has discovered the central sun about which our sun with its attendant planets performs its circuit. His conclusions are derived from a comparison of catalogues of stars since the time of Brad-

ley. The following summary may give some idea of the nature of his labors.

1. Of 15 stars in the group of the Pleiades, there is a great uniformity in the proper motions, and a general decrease of declination.

2. Of 12 other stars observed by Bradley within 5° of the Pleiades, the declinations have been generally decreasing since 1755.

3. Of 35 stars observed by Bradley from 5° to 10° distant from the Pleiades, the same remark is true.

4. Of 57 stars observed by Bradley from 10 to 15° distant from the Pleiades, the declinations are generally decreasing.

Out of 110 stars within 15° of the Pleiades, whose declinations are given by Bradley, we find—

60 motions towards the South;
49 motions very slow and yet undetermined;
1 ? towards the North.

Mädler explains these facts by ascribing to the solar system a motion nearly perpendicular to the ecliptic. He also remarks that the proper motions of the stars increase with their distance from the Pleiades, the greatest proper motions known (5 to 6″) occurring at a distance of about 90°. Mädler therefore concludes that the Pleiades constitute the central group of the system of fixed stars which compose the Milky Way, and that Alcyone is that particular star which is most probably the true *central sun*.

Alcyone, known also as *η Tauri*, or 25 *Tauri*, is a double star of the third or fourth magnitude in A. R. 3h. 38m.; Dec. 23° 39′ N.

Mädler estimates the distance of Alcyone from us to be such as light would require 537 years to traverse.

The time of one revolution of the sun about Alcyone he estimates at 18 millions of years. The mass of all the bodies whose distance from the central sun is not greater than our own, he estimates at 117 million times that of our sun.

Prof. Schumacher in giving place to this remarkable memoir in the Astronomische Nachrichten, intimates that he entertains some doubts respecting the conclusions—doubts which will probably be shared by many other astronomers.

4. *Antares.*—The announcement of the triplicity of the star *Antares*, at p. 280, was premature. It is probable that the appearance of the minute companion of a green color, is a result of prismatic dispersion; and that Antares is consequently a *double* star only.

5. *The new Planet Astræa.*—This newly discovered member of our system was followed at the principal European Observatories until it came too near the sun to be longer observed. The following are the

latest observations we have seen, and were made at the Berlin Observatory by Professor Encke.

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| May 12, | $9^h$ | $57^m$ | $46{\cdot}2^s$ | m. t. | A. R. | $100°$ | $44'$ | $8{\cdot}1''$ | Dec. | $+21°$ | $36'$ | $0{\cdot}2''$ |
| 13, | 9 | 41 | 27·1 | " | " | 101 | 16 | 1·8 | " | 21 | 35 | 25·2 |
| 18, | 10 | 20 | 27·2 | " | " | 103 | 59 | 44·4 | " | 21 | 30 | 56·2 |
| 22, | 9 | 48 | 8·2 | " | " | 106 | 10 | 32.0 | " | 21 | 25 | 16·0 |

The following elements obtained by Mr. Graham of Markree Observatory, from observations of Dec. 17, Jan. 20, and Feb. 17, accord remarkably well with those obtained by Professor Encke from the first two weeks' observations.

Epoch 1846. Jan. 1·0. Greenwich M. T.

| | | | | |
|---|---|---|---|---|
| Mean longitude, | 94° | 46′ | 51·14″ | |
| Mean anomaly, | 319 | 29 | 32·32 | |
| Perihelion, | 135 | 17 | 18·82 | Mean equinox, |
| Node, | 141 | 16 | 59·46 | 1846, Jan. 1·0. |
| Inclination, | 5 | 19 | 59·06 | |
| Eccentricity, | 0·1936831 | | | |
| Semi-major axis, | 2·593452 | | | |
| Mean motion, | 849″·5508 | | | |
| Revolution, | 1525·5 days. | | | |

It is gratifying to learn that Mr. Hencke has received various honorable testimonials for his discovery of this planet. The King of Denmark awarded to him a gold medal with the inscription, *Ingenio et Arti*. The King of Prussia also awarded to him a gold medal, and conferred upon him the order of the Red Eagle, IV, with an annual pension of three hundred dollars. E. L.

6. *Biela's Comet.*—In our May No. we have given some information respecting the extraordinary phenomena of this body. It was attended by a companion like a secondary comet, which was very remarkable for its changes of magnitude and brilliancy. This companion was noticed at Washington, Jan. 13, and this is the first notice of it we have seen from any quarter of the world, except the observation at New Haven, Dec. 29, 1845. At Cambridge, Eng., the phenomenon was first noticed Jan. 15th, though the first measurement of distance we have seen was for Jan. 23. On the 15th of January also, M. Wichmann at Königsberg noticed a faint nebula near the comet; and on the 26th, perceiving that the distance between the two bodies had changed, he commenced a series of measurements. At Naples the companion was first noticed Jan. 19; at Berlin, Jan. 27; at Geneva, Feb. 3; and at Dorpat, Feb. 13.

The following observations give the differences of Right Ascension and Declination of the two bodies. They were all made at Wash-

ington with the exception of the last two, which were made at Cambridge, Eng.

| | Diff. A. R. | Diff. Dec. | | Diff. A. R. | Diff. Dec. |
|---|---|---|---|---|---|
| Jan. 13, | about 4·0$^s$ | 1′ or 2′ | Feb. 13, | 8·6$^s$ | 4′ 38″ |
| 14, | 4·0 | 1′ 18″ | 16, | 9·7 | 5 4 |
| 18, | 4·5 | 1 47 | 18, | 9·9 | 5 17 |
| 19, | 4·3 | 1 48 | 21, | 11·7 | 5 52 |
| 22, | 5·3 | 1 57 | 22, | 12·1 | 6 4 |
| 23, | 5·1 | 2 0 | 26, | 14·8 | 6 48 |
| 24, | 5·5 | 2 3 | March 3, | 19·4 | 7 35 |
| 26, | 5·5 | 2 19 | 4, | 21·4 | 8 11 |
| 28, | 5·6 | 2 27 | 5, | 22·5 | 8 7 |
| Feb. 4, | 6·2 | 3 10 | 8, | 25·1 | 8 28 |
| 5, | 6·5 | 3 21 | 10, | 26·6 | 8 52 |
| 9, | 7·1 | 4 1 | 14, | 32·7 | 9 10 |
| 11, | 7·7 | 4 1 | 21, | 42·9 | 8 44 |
| 12, | 8·0 | 4 29 | 25, | 46·3 | 8 23 |
| | | | 27, | 47·4 | 7 54 |

The following observations show the changes of brightness which the two bodies experienced.

Jan. 13th, the companion was first seen at Washington, but too faint for accurate measurement. It was estimated to have one eighth the magnitude and one fourth the intensity of Biela, or the main body. From this time, the companion increased rapidly both in magnitude and brilliancy. On the 12th of February the companion appeared the brightest, and on the 16th, the companion was estimated to be equal to Biela as to magnitude, but to have one third more intensity of light. On the 18th of February, Biela exceeded his companion at least twofold both in magnitude and intensity of light. From this time the companion rapidly declined; and on the 3d of March it was estimated at one sixth of Biela. March 10th, the companion was estimated at one twentieth the brightness of Biela, and at Berlin it was pronounced too faint to be observed, although Biela was followed till April 24th. The companion was last seen at Washington, March 21st, and at Cambridge, Eng., March 27th, but "excessively faint."

The following notices of the physical appearances of these two bodies, as observed at Washington, will throw some light upon the nature of their connection with each other.

Jan. 14th, were noticed glimpses of a tail to each body; Biela's tail extending N. E., and his companion's nearly parallel with it.

Jan. 18. Tail of Biela only a few minutes of arc long, extending towards N. E., lancet like. Tail of companion not so long, but nearly parallel. Nuclei decidedly condensed towards the centre, but not resolvable into points of light except perhaps Biela's by glimpses.

Jan. 23. Companion has the appearance of two tails, one nearly parallel to Biela's, the other reaching over to his nucleus or rather just to the south of it.

Jan. 28. Biela exhibited a pointed nucleus; caught glimpses of a point of condensed light in nucleus of companion.

Feb. 4. A decided stellar nucleus to each comet, appearing like a sharp point of light. Tails reaching almost across the field and nearly parallel.

Feb. 11. The nucleus of companion decidedly stellar; that of Biela diffused, and by no means as bright.

Feb. 12. Glimpses of two nuclei in Biela; tail full one third across the field. Tail of companion nearly parallel with Biela's. Catch glimpses of another tail extending towards Biela just above a straight line between the two, and in a sort of arch. Appearance of two tails to Biela, second going off in a direction opposite from companion.

Feb. 21. Ragged condensation of light in nucleus of Biela. Both tails parallel, extending across the field.

Feb. 22. A band of nebulous matter, a little arched, joins the two. Appearance of a double nucleus about Biela. Has three tails radiating at angles of 120° to each other. The tail of Biela extends three times the field, say 45′.

Feb. 26. Biela has a tripod tail—the one extending opposite to the companion very distinct. Confused appearance about the nucleus of Biela as though there were several nuclei.

March 5. Companion has no apparent nucleus; is exceedingly faint, and without any mark of condensation.

March 8. One of Biela's tails points directly east—the other remains as it was.

March 10. No stellar nucleus to either comet. No tail to Biela by the moonlight.

March 14. Appearance of cometary fragments about Biela. Counted five of them in this position ⁂ .

March 17. Companion is a very diffused mass of exceedingly faint nebulous matter. No appearance of fragments about Biela.

March 21. Companion very faint, muddy; a shining point in a dim patch of light about its nucleus.

March 30. Saw the two tails to Biela as formerly. Companion could not be seen.

From the preceding observations it probably will not be doubted that these two bodies had some connection with each other; that the one which we have called Biela was the main body; and that the companion was formed of matter which proceeded from Biela. The question

then arises, how did the companion become detached from Biela. Was it by an internal explosion? Admitting the possibility of an explosion by which a cometary body might be torn into fragments, the rapid increase of size and brilliancy of the companion compared with Biela, from Jan. 13th to Feb. 16th, seems hardly explicable except upon the supposition of *a continued transfer of matter* from one body to the other for an entire month. It seems then most natural to suppose that the cause of this continued transfer was the same as that of the first formation of the companion. If this formation appears mysterious, we have at least observed phenomena in the case of other comets which possibly may have some analogy with this. Halley's comet at its last return was observed to emit streams of fiery matter, which presented the appearance of sectors of extreme brilliancy. The matter thus emitted from the head diffused itself in the direction opposite the sun, and formed the tail of the comet. The attraction of these particles of matter for each other was scarcely, if at all, appreciable. Suppose however the existence of a feeble attraction among these particles. A few of these collecting together would form a nucleus to which other neighboring particles would be attracted, and thus the particles emitted from the head would form a second nebulous body not unlike the companion of Biela. According to the rate of separation when first observed, these two bodies must have been together about the 1st of January. At this time then we may suppose Biela's comet to have commenced emitting particles from its head, which uniting by feeble attraction formed a small nebulous body. Perhaps when the repulsive force began to operate, it may have been for a time resisted by an envelop partaking somewhat of the character of a solid body; and when this resistance yielded, a considerable portion of the main body may have been at once detached by a sort of explosion. A fragment thus detached might attract to itself at least a portion of the stream of particles which continued to be emitted from the main body. Thus the companion increased at the expense of Biela until the 16th of February, which was soon after its perihelion passage. At this time the distance of the companion was such that it could no longer attract to itself the matter repelled from Biela. It therefore ceased to grow, and indeed appeared to decline in brilliancy, perhaps from the loss of matter which it emits in the same manner as Biela; although we have an example in the case of Encke's comet of a body which habitually becomes much less conspicuous after than before perihelion passage.

On the whole it must be admitted that the phenomena of comets are altogether anomalous. The comets of Halley, Encke and Biela, those of 1824 and of 1744, have exhibited phenomena which seem to require us to admit the existence of matter of a different kind from any thing we witness upon the earth. E. L.

7. *Fourth Comet of* 1846.—The observations mentioned under this title (p. 138) appear to be memoranda referring to Biela's Comet.

The Comet discovered March 8, 1846, by *Brorsen* is identical with that discovered by *de Vico*, Feb. 20, 1846, and by Mr. *Geo. P. Bond*, Feb. 26.

8. *Fifth Comet of* 1846.—This Comet, whose perihelion passage occurred June 4–5, (see p. 138,) was first detected by *Brorsen*, on the night of April 30, 1846.

9. *Hind's Comet.*—A telescopic comet was discovered between the Camelopard and Cassiopeia, by Mr. *J. R. Hind* at Mr. Bishop's Observatory, Regent's Park, London, July 29, 1846, 11h. 10m., P. M. Its approximate place was, July 29, 12h. 6m. 6s., Gr. m. t. A. R. 3h. 15m. 35·2s.—N. Decl. 60° 37′ 2″.

The R. A. was diminishing and N. Decl. increasing.

Mr. Hind gives the following elements:

| | | |
|---|---|---|
| P. Pass., · · | 1846, May 14·11425 Gr. m. t. | |
| Long. of Perihelion, | 102° 43′ 56″ | App. Eqx. July 30. |
| " " Asc. Node, | 164 18 10 | |
| Inclination, · · · | 59 27 7 | |
| Log. Perih. dist., . . | 0.0628684 | |
| Motion, . . . . | retrograde. | |

10. *Le Verrier's Planet.*—The new planet, whose existence M. Le Verrier demonstrated mathematically from the inequality in the motions of *Uranus*, was actually discovered by M. Galle of Berlin, Sept. 23d, 1846. This grand discovery is announced in a letter from Dr. Brünnow of the Royal Observatory at Berlin, dated Sept. 25th. He says, "the planet resembles a star of the 8th magnitude, but with a diameter of two or three seconds. Its motion is now retrograde, at the rate of four seconds of time daily. Below are two of its places:—

Sept. 23, 12h 0m 14s·6 m. t. R. A. 328° 19′ 16″·0 S. Decl. 13° 24′ 8″·2
" 24, 8 54 40 ·9 " " 328 18 14 ·3 " 13 24 29 ·7

Mr. Hind at Mr. Bishop's Observatory, Regent's Park, London, observed the new planet Sept. 30, notwithstanding the moonlight and hazy sky, and with a power of 320 he saw the disc. Its place was Sept. 30, 8h 16m 21s Gr. m. t. R. A. 21h 52m 47s·15. S. Decl. 13° 27′ 20″.—*Lond. Athenæum, Oct.* 3.

## VI. Miscellaneous Intelligence.

1. *Improvement in the construction of the Rails and Wheels of Railroads.*—Mr. C. H. Greenhow of London has published a pamphlet in which he condemns flanged wheels, and recommends circular rails and concave tire as much better adapted to the ever varying circumstances of a long line—such as curves, loose chairs, sprung rails, &c.

2. *Manufacture of Gas for illumination, from Water.*—M. Jobard has succeeded in giving to hydrogen a high illuminating power; the gas burns with a white and brilliant flame equal to thirty six candles of six to the pound.

This gas was charged with carbon by passing it through a cylinder containing about two quarts of oil of gas tar; but as the gas deposited its mechanically suspended carbon, M. Jobard caused hydrogen gas obtained by the distillation (decomposition?) of water to take up hydrocarburets produced by the distillation of coal gas at the moment of formation: twice or thrice as much gas could be obtained as by the ordinary method, and the gas needed no purifying, especially when fish or other oils were employed.

The combined gases contain carburets of hydrogen, 57; oxide of of carbon, 28; and free hydrogen, 15. One hundred and eleven feet of gas were produced from every pound of oil.

3. *Board of Regents of the Smithsonian Institution.*—The following persons constitute the Board of Regents of the Smithsonian Institution. The Vice President of the United States. The Chief Justice of the United States. The Mayor of the city of Washington. Messrs. Evans, Pennybacker, and Breese of the Senate. Messrs. R. D. Owen, W. J. Hough, H. W. Hilliard, of the House. R. Choate, Mass., G. Hawley, N. J., Richard Rush, Pa., William C. Preston, S. C., A. D. Bache, and J. G. Totten of Washington.

Preparations are making to go on at once with the erection of buildings, and the organization of the institution.

4. *Wollaston Medal.*—The Wollaston Medal has been presented by the Geological Society of London to Mr Lonsdale, well known for his various contributions to Palæontology, and especially in the difficult department of fossil corals.

5. *Geological Society of France;* (L'Institut, No. 655, July 2, 1846, p. 252.)—This society held its annual session at Alais (Gard), on the 30th of August, this place being selected on account of its great Geological interest, as it combines the richest coal beds of France, mines of iron and lead, the jurassic formation and the lower cretaceous.

6. *Prof. Louis Agassiz.*—This distinguished European naturalist arrived at Boston about the first of October. We learn with pleasure that he will spend several years among us, in order thoroughly to understand our natural history. M. Desor, his companion in the glaciers of Switzerland, and Mr. Dinkel, the artist of his beautiful plates, are soon to join him in this country.

7. *M. de Verneuil* has left for Paris, but will again return after a year.

8. *The Ray Society.*—We call attention to the prospectus of this useful society, which will be found among our advertisements.

9. *The Association of American Geologists and Naturalists*, held its seventh annual session at New York, as previously announced, on the 2d of September and the week thereafter. We publish in the present number of this Journal, two papers which were read at this meeting; and further notice of their doings will be given on another occasion.

10. *The British Association* met at Southampton on the 10th of September, under the direction of Sir Roderick I. Murchison. We understand from a gentleman who has been present on several previous occasions, that this meeting was one of uncommonly high character. Their proceedings have reached us through the kindness of Mr. Lyell, but too late for notice in this volume.

11. *Museum of Economic Geology in Great Britan;* (from the Anniv. Address by L. Horner, Esq., before the Geol. Soc. of London, Quar. Jour. Geol, p. 152.)—In his Anniversary Address of 1840, Dr. Buckland adverted to the recent establishment, by the Government of that time, of the Museum of Economic Geology. It not only received encouragement from their successors, but has been placed by them on a more enlarged and comprehensive plan. During the last year the Geological Survey of Great Britain and Ireland has been transferred from the direction of the Master General of the Ordnance to that of the Chief Commissioner of her Majesty's Woods and Works; and that Survey and the Museum of Economic Geology are now united under one management. The establishment is supported by an annual parliamentary grant, which in the last session amounted to 8850*l.*, including the Museum of Economic Geology in Dublin; and large premises are about to be built by Government in a central part of the metropolis for the accommodation of the several departments, the extension of the Museum, and the accomplishment of other useful plans that are in contemplation. It is a reproach to former Governments that the formation of such an institution should have been left to recent times, in a country deriving so much wealth, importance and power from its mineral treasures.

When we consider the high qualifications of the officers selected by the Government for carrying out this scheme, we may look forward with confidence to their rendering important services to geological science, as well as to mining interests, the arts and manufactures. Sir Henry De la Beche is, as you are aware, the Director-general; and his indefatigable zeal and exertions, and above all the judgment shown by him in his recommendations of the other officers, cannot be too highly estimated. Mr. Andrew Ramsay is Director of the Survey of

Great Britain; Captain James, of the Royal Engineers, is Director of that of Ireland; Professor Edward Forbes is Palæontologist, and Mr. Warrington Smyth, Mining Geologist for the United Kingdom; and there is reason to believe that Dr. Hooker will be appointed to the department of Botany.* Mr. John Phillips is engaged in the Survey of the North of England, and one laboratory of the Museum of Economic Geology is under the direction of Mr. Richard Phillips, one of the founders of this Society, and another under the direction of Dr. Lyon Playfair. There are besides several able officers in different departments.

BIBLIOGRAPHY.

1. *The Sidereal Messenger, a Monthly Journal, devoted to Astronomical Science.* 4to. Monthly. 8 pp. each, with engravings. Cincinnati, O. Price $3 a year.—Prof. O. M. Mitchel, the able and enterprising director of the Cincinnati Observatory, has undertaken a periodical work, whose title we have cited above. Its object, as stated in the prospectus, is "to record in a plain and simple form, the results of the researches made with the great achromatic refractor of the observatory,—to present the earliest astronomical intelligence from all parts of the world,—to furnish to our countrymen, in their own language, the most interesting articles from foreign astronomical journals,—to excite an interest among the people in the elevating study of astronomy,—and to give a permanent support to the Institution under whose auspices the publication is made." Four numbers are already issued, containing the articles named below, besides various other interesting notices.

Account of the Cincinnati Observatory, and the Great Refractor.
Telescopic View of the Moon.
Account of Biela's Double Comet.
Maedler on the Central Sun.
Prof. Loomis on the Physical Constitution of the Moon.
Extraordinary Phenomena observed during the Total Eclipse of the Sun, July 7, 1842.
Orbitual Motion of the Double Stars.
Observations on Double Stars, made with the Cincinnati Refractor.
Letters from Eminent Foreign Astronomers.

This Journal, the first on our Continent, devoted solely to astronomy, promises to be highly useful to the science of the country, and reflects great credit on the city of its birth. We trust it will be liberally supported.

2. *The Trees of America, native and foreign, pictorially and botanically delineated, and scientifically and popularly described, etc., illustrated by numerous engravings;* by D. J. BROWNE, New York, 1846, Harper & Brothers. 1 vol. large 8vo, pp. 520.—This is the work of a

* Dr. Hooker's appointment has since taken place.

person truly fond of his subject, and who has evidently devoted no little attention to it. The wood-cuts are pretty good, the typography and paper are handsome, and the volume contains much well selected and some original popular matter. The author leaves us in much doubt as to the extent of the field he means to embrace. Though we find no statement restricting the general title "Trees of America," we presume, on the whole, that those of the United States only are intended which may be termed *par excellence* American, in the same way that the continental title is applied to our citizens abroad. What is meant by the "*foreign* trees of America," is not so clear, since Mr. Browne has omitted many of the common hardy exotics cultivated among us, while he has given such as the *Pistachio-nut*, the *Paraguay Tea*, the *Prunus avium*, of Europe, (which stands in his book under the name of "The Wild Cherry tree," to mislead the general reader,) the *Laurus nobilis*, or True Laurel, and lastly the *Camphor-tree*, which is surely "foreign" enough. On the other hand, the greater part of our Thorns, our wild Crab-trees, the Southern Prickley Ash, two of our Rhododendrons, and a large portion of our commonest taller shrubs are entirely unnoticed; not that shrubs do not fall within the range of the work; for the low Canadian Barberry, the *Æsculus macrostachya* and the *Ilex vomitoria*, &c., are given in full. Upon examination we find the book closes abruptly with the Elm family; the Amentaceous and Coniferous trees, that is, *our principal forest trees*, being left to the contingency of another "supplementary volume," to be published or not, as circumstances may warrant;—which we suspect is not exactly according to the terms of subscription. We should not have remarked upon this, nor upon the singular notion of making the Oaks, Hickories and Pines play a *supplementary* part to Oranges, Almonds, Pomegranates, Myrtles, Figs and Camphor-trees, in a work on the "trees of this country more complete and extensive than had hitherto been published," if there had been any indication upon the title-page or cover, or even an explicit statement in the preface, that this is only the first volume of a work on our trees, and in itself incomplete. This is "a trick of the trade," for which perhaps the author himself is not directly responsible. That we do not consider Mr. Browne as high botanical authority will not be surprising, when it is seen that he describes the *Ohio Buckeye* as a variety of the *common Horse Chestnut*, the *Rhus glabra* as a variety of the *Rhus typhina*, the *Robinia hispida* or *Bristly Locust* as a variety of the *pseudacacia* or common Locust-tree; states his confident belief that the *Choke Cherry* and the *Wild Black Cherry* (*Cerasus virginiana* and *C. serotina*) are one and the same species; confounds in the same way all our species of Ash under *Fraxinus americana*, and all our Elms, even the *Wahoo*, and *Slippery Elm*, under *Ulmus amer-*

*icana*. Some of these mistakes are copied from Loudon; but an American writer on the trees of his own country, who professes to exercise his own judgment on these points, should have corrected such obvious errors, instead of adding to them. Some liberty is taken with the poetry as well as the botany. A part of those beautiful lines—

> "Wise with the lore of centuries,
> What tales, if there were tongues in trees,
> Those giant oaks could tell,"—

are "conveyed" to the Pittsfield Elm, without a sign to indicate the change. The fruit of *Cratægus spathulata* is said to be of "the smallness of a grain of mustard-seed, (p. 274.) The venerable Hales is said to be the author of "Vegetable Statistics"—instead of *Vegetable Statics*. Mr. Browne, following Michaux, says, "The wood of *Olea americana* is excessively hard, and difficult to cut and split: hence the provincial name of *Devil-wood*," (p. 382.) An insufficient reason, one would think, for the bestowal of such an ungracious cognomen. We have heard a better and more probable explanation,—viz. that the wood in burning snaps loudly, throwing the fragments explosively from the hearth. We should like to know our author's authority for the following curious statement respecting the Sassafras-tree. "The most interesting historical recollection connected with this tree is, that it may be said to have led to the discovery of America; as it was its strong fragrance smelt by Columbus that encouraged him to persevere when his crew were in a state of mutiny, and enabled him to convince them that land was not far off," (p. 417.) Acute olfactories the great navigator must have had, to snuff the fragrance of Sassafras groves in Florida, more than five hundred miles off! Besides, now-a-days, the flowers of Sassafras are almost scentless. With the greatest propriety does the author say that he "feels called upon to acknowledge that he is particularly indebted to Mr. Loudon *for a large share of his work*, taken from the Arboretum Britannicum, and to Dr. Thaddeus W. Harris, for many valuable extracts from his Report on the Insects of Massachusetts injurious to vegetation." From the latter copious abstracts of the highest interest have been very freely taken; indeed nowhere, beyond Dr. Harris's own volume, will so large an amount of his invaluable researches be found embodied, as in Mr. Browne's work.

A. Gr.

3. *Outlines of Structural and Physiological Botany;* by Arthur Henfrey, F. L. S., etc. With numerous illustrations. In three parts. Part I, Elementary Structures. Part II, Organs of Vegetation. pp. 106, 12mo. London, 1846. Van Voorst.—The third part, "containing the Organs of Reproduction and General Physiology," is doubtless by this time published, completing this compendious but exceedingly

useful treatise. Its particular object, the author informs us, is to "put the student in possession of the results of the numerous and important researches which have been published within the last few years in this department of science," especially by the German observers, who are prosecuting their investigations in vegetable anatomy with such zeal and success, researches which, scattered as they are through various journals, or contained in voluminous works, and to a great extent locked up in a foreign and difficult language, are placed quite "beyond the reach of many who are interested in them, especially of those whose time is so valuable as that of medical students." This little work accordingly is very valuable as a summary of the most recent views and discoveries in vegetable structure, giving special prominence to the formation and metamorphosis of tissues, the phenomena of growth, &c. It is not a mere compilation, but a careful digest, evidently prepared by one who is thoroughly conversant with his subject; the topics are admirably arranged, and the results succinctly and for the most part very clearly stated. Without waiting for the concluding part, therefore, we may unhesitatingly commend this little treatise to the general, and especially to the medical student. Compendious as it is, we know of no work in the English language which gives so much information upon vegetable anatomy in such a small compass, or so well exhibits the present state of knowledge and opinion upon this class of topics. A. Gr.

4. Delessert, *Icones Selectæ Plantarum quas in Prodromo Syst. Nat. ex herb. Parisiensibus, presertim ex Lessertiano, descripsit, Aug. Pyr. DeCandolle*, Vol. 5, 1846, (100 plates, folio.)—The fine illustrated work for which botanists are so greatly indebted to Baron Delessert, has just reached its fifth volume. The principal families here illustrated, are the Lobeliaceæ, Ericaceæ and Epacrideæ, Myrsinaceæ, Sapotaceæ, Styracaceæ, Apocynaceæ, and Asclepidaceæ. The following plants of our own country are figured, viz. *Dipholis salicifolia*, a Sapotaceous tree which we believe is found at Key West; *Enslenia albida*, without the fruit; and *Podostigma pubescens*. Having recently noticed the interesting volume which M. Lasègne has devoted to an account of the immense herbaria and almost complete botanical library of Baron Delessert, we may take this opportunity to state that Prof. Alph. DeCandolle has made it the subject of a very instructive review, in a late number of the *Bibliothèque Universelle*, of Geneva.

A. Gr.

5. *A Text Book on Chemistry, for the use of Schools and Colleges*; by John William Draper, M. D. Harper & Brothers, 1846. 12mo, pp. 408.—This text book follows the same order of arrangement which Prof. Draper has been accustomed to adopt in his lectures. It is terse, lucid and philosophical, and appears to be well adapted to the object for which it is published.

6. *Adulterations of various Substances used in Medicine and the Arts*, with the means of detecting them; by LEWIS C. BECK, M. D. New York, S. S. & W. Wood, 1846. 12mo, pp. 332.—Following an alphabetical arrangement, Dr. Beck has presented in the present volume much valuable information on all the common articles of commerce and medicine which are known to be adulterated, as well as on many which are more rare. He has also pointed out the mode of detecting the adulterations by the application of proper chemical tests. The practical usefulness of this volume sufficiently recommends it.

7. *Observations in Natural History*, with an Introduction on Habits of Observing as connected with the Study of that Science, &c. &c.; by the Rev. LEONARD JENYNS, M. A., F. L. S., etc., Vicar of Swaffham Bulbeck. London, J. Van Voorst, 1846. 12mo. pp. 440.—This scrap book is made up in a diary form, of the notes of interesting facts in Natural History observed by the worthy vicar and collector during the past twenty years. They embrace a great variety of subjects, and are written in the same flowing easy style which made White's Selborne one of the favorite companions of our youthful days. The volume is introduced by a chapter on habits of observation, and the value of such habits is well enforced by the silent example of the Rev. Jenyns, whose intervals of parochial duty have been filled with the varied pleasures which nature always awards to her votaries. This volume is closed by a calendar of periodic phenomena in natural history, with a chapter on the importance of such registers.

8. *A Monograph on Fossil Crinoidea;* by THOS. AUSTIN, Esq., F. G. S., and THOS. AUSTIN, Jr., Esq., A. B. J.—This work is now publishing in numbers, of which the first five have reached us through the attention of the authors. It is in quarto, each number being illustrated by two elaborate plates drawn from the best specimens and fully described. The work will be complete in about twenty parts, at 3s. 6d. each, and is published by subscription by J. Tennant, 149 Strand, London.

9. *The Brain and its Physiology, &c.;* by DANIEL NOBLE, member of the Royal College of Surgeons, London. J. Churchill, London, 1846. 8vo, pp. 450.—The object of this volume—which is ably written—is to support the doctrines of Gall and Spurzheim by anatomical and physiological proofs.

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Correlation of Physical Forces, by W. B. Grove, Esq., royal 8vo, *London*, 1846.

Voyages de la Commission Scientifique du Nord en Scandinavie, en Laponie, au Spitzberg et aux Feroë, pendant les années 1838, 1839 et 1840, sous la direction de M. Gaimard. *Paris.* The 40th livraison has appeared. The work will form 20 volumes in 8vo, and 7 folio atlases, containing 516 plates.

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Naturgeschichte der Infusionsthiere; by Prof. S. Kutorga, with an Atlas. St. Petersburg, 1839; in German, 144 pp. 8vo, and 4to atlas, Carlsruhe, 1841.

Thesaurus Literaturæ Botanicæ omnium gentium; G. A. Pritzel. Leipsic. Announced for 1847, by F. A. Brockhaus.

## SCIENTIFIC RESEARCHES.

Annals of the Lyceum of Natural History of New York, Vol. iv, Nos. 6, 7. August, 1846.—p. 171. Description of a new species of Anser (A. nigricans) with a plate; *G. N. Lawrence.*

p. 172. A Descriptive Catalogue of the Geodephagous Coleoptera, inhabiting the United States east of the Rocky Mountains; with two plates; *John L. Le Conte.* In connection with the Catalogue there are descriptions of species of the following genera: Cicindela, Galerita, Cymindis, Calleida, Axinopalpus (nov. gen.), Dromius, Lebia, Coptodera, Thyreopterus, Brachinus, Dyschirius, Clivina, Pristodactyla, Rhadine (nov. gen.), Anchomenus, Agonum, Olisthopus, Pœcilus, Adelosia, Stereocerus, Argutor, Piesmus (nov. gen.), Lyperus, Feronia, Steropus, Broscus.

Annals and Magazine of Natural History, *August*, 1846, *No.* 117. Notices of British Hypogæous Fungi; *M. J. Berkeley* and *C. E. Broome.*—Regular Arrangement of crystals in certain organs of Plants; *E. J. Quekett.*—Remarks on certain genera belonging to the class Palliobranchiata; *W. King.*—Excursions in Upper Styria; *R. C. Alexander.*—Birds of Calcutta; *C. J. Sundevall.*—Structure of Cucurbitaceæ; *J. E. Stocks.*—Ornithology of Tobago; *W. Jardine.*—*Zoological Society, March* 24, 1846. New species of shells; *J. H. Jonas.*—April 14. Twenty new Helicea, in the collection of H. Cumming; *L. Pfeiffer.*—*June* 9. Three new Trochilidæ; *Mr. Gould.*—*June* 23. On the Dinornis; *R. Owen.*

*September, No.* 118. Growth of cell-membrane; *H. v. Mohl.*—Generation of Ixodes; *Prof. Gené.*—Description of 13 species of Cephalopus in the Brit. Mus.; *J. E. Gray.*—Birds of Calcutta; *C. J. Sundevall.*—Four new genera of Crustacea; *A. White.*—New genus of Arachnida, family Attidæ; *A. White.*—New Mammalia (Herpestes, Felis, Pteromys and Jacchus); *J. E. Gray.*—Two new Antelopes; *J. E. Gray.—Linnæan Society, Feb.* 17. Axial and ab-axial arrangement of carpels; *T. S. Ralph.*—Caricis species nov., &c.; *Dr. Boott.*—March 17. Siliceous armor of Equisetum hyemale; *Golding Bird. Ap.* 21. Development of Starch and Chlo-

rophylle; *E. J. Quckett.*—*Zoological Society, July* 14. Forty new species of Haliotis, in the collection of H. Cuming; *L. Reeve.*—Fifty-four new species of Mangelia, in the collection of H. Cuming; *L. Reeve.*

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*March.*—*Zoology.* On the Tergipes Edwardsii; *A. de Nordmann*, (continued.) Note on the development of the Chelonia; *H. Rathke.*—On the development of the Spermatozoids of the Ray and Torpedo; *M. de Martino.*—On the mechanism of the secretions; *A. Lereboullet.*—On the temperature of the Spatangus purpureus, Trigla hirundo and Gadus æglefinus of the Northern Seas; *Ch. Martius.*—On the testicles and spermatozoids of the Patellæ; *Lebert* and *Robin.*—*Botany.* On the Fungi of the Paris Museum; *J. H. Léveillé.*—On the composition and structure of several organs of plants; *Mirbel* and *Payen.*—On the absorption of arsenic by healthy and living plants; *A. Targioni-Tozzetti.*

*April.*—*Zoology.* On the composition and structure of the envelop of the Tunicata; *Lævig* and *Kalliker.*—Report on the same; *Payen.*—Researches on Zoophytes; *Dana.*—On different species of fossil mammifera of the south of France; *P. Gervais.*—*Botany.* On the organization of the Myrodendron; *J. D. Hooker.*—On the temperature of 1846, and its influence on the flowering of plants; *C. Martius.*—Monograph of the genus Cardopatium; *E. Spach.*—On the anatomical structure of the Cuscuta and Cassytha; *J. Decaisne.*—On the Fungi of the Paris Museum; *J. H. Léveillé.*

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Archiv für Naturgeschichte, 1846, No. 2. Appendix to Gurlt's list of Entozoa, arranged according to the animals they inhabit; *Creplin.*—New or little known Annelida; *H. Grübe.*—Macrocolus, a new genus near Jaculus; *A. Wagner.* Flying mouse of Surinam; *F. Krauss.*—Observations on the Lutra lutreola; *v. Siemuszowa-Pietruski.*—On the Polish Beaver; *ibid.*—Structure of the Ganoidea; *J. Müller.*—Review of works and Memoirs in Physiological Botany for 1844, 5; *H. F. Link.*

Index photographed at the
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